UNIVERSITY OF BRISTOL.

THE ANNUAL REPORT

OF THE

Agricultural and Horticultural Research Station.

(THE NATIONAL FRUIT AND CIDER INSTITUTE).

LONG ASHTON, BRISTOL,

1926.

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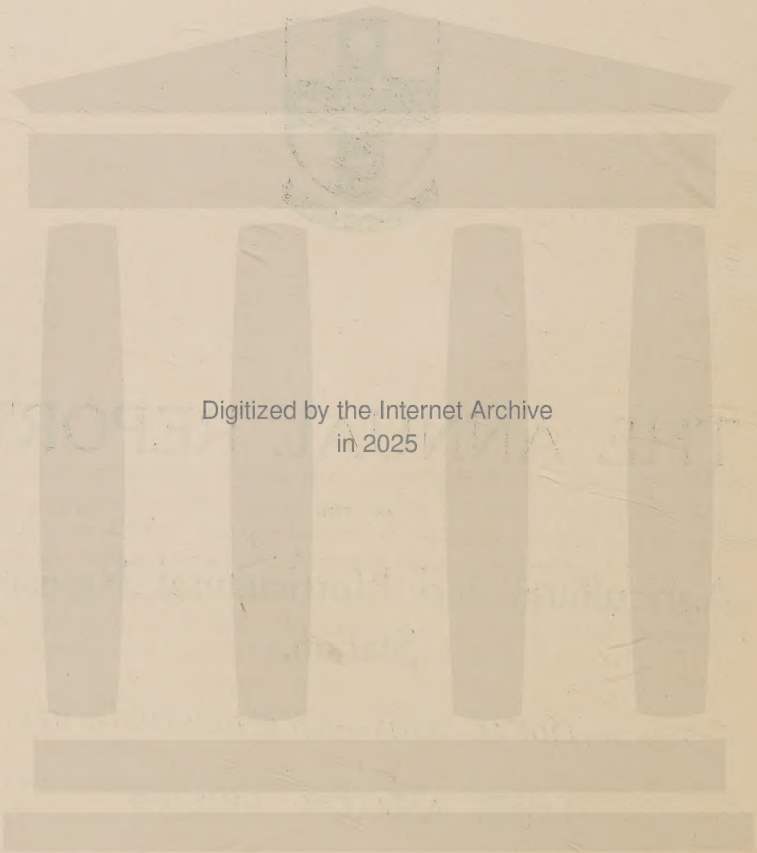

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CONTENTS.

INTRODUCTION.

While the present Annual Report is intended to deal primarily with the activities of that section of the Agricultural and Horticultural Department of the University of Bristol located at the Long Ashton Research Station, (the National Fruit and Cider Institute), the association between the latter and the two other sections of the Department, at Berkeley Square, Bristol, and the Campden Research Station respectively, is so close and the work so interwoven that some reference to those centres becomes inevitable. This is particularly the case in respect of the advisory side of the work of the Department.

The following introduction to the Report therefore relates to the more important events of the year 1926 concerning the Department as a whole. The part of the Report referring to research deals only with matters undertaken by Long Ashton. Although that does not contain the whole of the material published from the Station, there is included a list of all publications which appeared in outside scientific journals. For various reasons no reference is made to several other investigations in hand, which will be dealt with in due course in later Reports.

Before passing on to the work of each section of the Department, the customary acknowledgement of the services of the administrative and labour staffs should be made. It is gratifying to be able to record each year their constant and loyal help.

Long Ashton Research Station.

As in 1925, changes in staff have been relatively few during the year under review. As a result, comparatively uninterrupted work and commensurate progress in most directions can be recorded. In fact, as regards both the research and advisory sides, the year has probably been the most productive and useful in the history of the Long Ashton Institute.

Some disappointment has been expressed at the discontinuance of the series of Open Days, started in 1925. The decision to suspend them during 1926 was arrived at after very careful consideration, during which the conflicting claims of the research and educational aspects of the case were fully reviewed. Those who are aware of the amount of preparation and expense attached to the arrangement of exhibits and demonstrations at Shows and of visiting parties to

the Station, and the dislocation of internal work incidental to these educational efforts, will appreciate the heaviness of the call required to carry through the programme of work for the year reported on below. To have added any further items to the programme would have entailed a degree of interference with the primary purpose for the existence of the Station which would have been difficult to justify. Moreover, it should not be overlooked that the Station, while open at any time to visitors, sets aside each Wednesday as a regular Visiting Day, and arranges for a member of the staff to be available on those days to demonstrate the work in progress and deal with enquiries on any subject coming within its province.

Staff. The appointment of Dr. H. R. Briton-Jones to the post of Professor of Mycology at the Imperial College of Tropical Agriculture, early in 1926, created a vacancy on the research staff which has been filled by the appointment of Mr. R. W. Marsh, B.A., as Research Mycologist.

At Xmas, 1926, Mr. T. W. Swarbrick, Ph.D., terminated his period of study at Long Ashton as a research scholar of the Ministry of Agriculture and has proceeded to Wisconsin, U.S.A., in order to complete his training.

Mr. H. D. Bennett, M.Sc., another student of the Ministry, is attached to the Station for the completion of his studentship period. He is assisting in certain of the pomological and plant physiological investigations in progress.

Mr. P. T. H. Pickford, after undergoing a special course of training in cider-making, has been appointed Cider Instructor under the scheme for the provision of local instruction in cider-making for the counties of Dorset, Monmouth and Worcester.

The special investigation on the composition of tar oil spray fluids carried on by Mr. L. E. Smith, Ph.D., has been concluded on his departure to Germany for a course of study at the Institut für Kolloidforschung, Frankfurt a/M. A further special grant has been received from the Ministry of Agriculture to enable the trials with the new spray fluids, compounded on formulæ proposed by Dr. Smith, to be completed.

Dr. Steward, of the Botanical Department of Leeds University, spent a part of the summer at Long Ashton in pursuance of his investigation on certain materials which can be leached from the leaves of fruit trees, a line of work closely associated with that upon which Messrs. Wallace and Mann are already engaged at the Station.

Land and Plantations. The difficulties confronting the Institute in respect of the provision of suitable land to meet pressing needs for

the extension of field experiments on fruit culture arising from investigations already in hand were indicated in the last Annual Report. Unfortunately they are no nearer solution and the situation is actually more serious, since it is now clear that there is no chance of relief in directions which a year ago afforded some slight ground for hope. Unless some entirely new development in the situation occurs in the near future, a most regrettable check in that part of the work of the Institute which interests most closely the practical fruit grower must result.

During the year a 5 acre plot of some of the leading varieties of plums, worked on a selection of typical examples of plum rootstocks classified and propagated at the East Malling Fruit Research Station, has been planted up. Its primary purpose is to serve for the extension of the investigation on the "die-back" diseases of the plums, which Dr. Briton-Jones has had in hand for some time: in addition it will provide a test of the plum rootstock types under Long Ashton conditions. The plot is interplanted with strawberries, an attempt being made here, by applying knowledge gained from recent investigations at the Institute, to lay the foundation of a stock of plants of the leading commercial varieties superior in vigour and constitution to the stocks of comparatively low vitality and poor performance upon which growers have been obliged to fall back since the war. Other recently planted sections of strawberries on this plot and elsewhere are concerned with the various investigations on the culture and pathology of this fruit which have formed one of the main lines of work at the Institute during the past three or four years.

In connection with the research on manurial problems a plot of apples, in which effects of deficiency and balance of individual nutrients will be tested out, has been established. A second generation of plants has been set out on the original strawberry manurial trial plots and a deficiency series of plots for this fruit also has been provided.

Points of fundamental importance in tree building, shaping, and pruning will be investigated on a plot of apples planted during the autumn of 1926.

Extensions have been made to the selected "free" stock trial plantation of apples, the various seedling trials plots, and the willow and raspberry variety plots. Included in the latter is now a group of seedlings raised at the Institute which appear worthy of comparative trial on a fairly extensive scale against standard commercial varieties.

Buildings. The cottages, referred to in last year's Report as in

course of erection, have been completed and are in occupation by various members of the staff.

The need for laboratory extension also mentioned on that occasion has been officially recognised and a grant of £2,500 from the Development Fund for an addition to the existing laboratory building has been sanctioned on condition that an equal sum is contributed by the Institute. A promise of a special building grant of £2,000 from the University of Bristol has enabled this condition to be accepted by the Governing Body, and the new building will be started early in 1927.

General. The Annual Tasting Day was held on May 6th and proved a most successful function, considering the attendant difficulties resulting from the General Strike just then in progress. The number of visitors, although somewhat below the average of recent years, was unexpectedly large under the circumstances.

Two gatherings of particular interest were arranged to be held during the summer. The first, the summer provincial conference of the Association of Economic Biologists, unfortunately had to be abandoned at the last minute owing to the general dislocation of engagements and travelling caused by the general strike and has been deferred till the summer of 1928. The other, the annual meetings of the Research Council of the Ministry of Agriculture and Fisheries, extended over two days and afforded an opportunity of demonstrating the work of the Institute to representatives of the Ministry and the Development Commissioners dealing with the administrative side of agricultural research and the Directors of the other agricultural research stations in this country.

In addition the following organised parties visited the Institute during the year :—

The Bristol Education Committee's Gardening Classes.
Devon County Party.
Joint Committees of the Provincial Advisory Conference of the Harper Adams and Bristol Provinces.
Messrs. Ferris and Company's Horticultural Society.
The National Utility Poultry Society.
The Bristol Section of the Institute of Chemistry.
The L.M.S. Horticultural Society.
Dorset County Party.
The Somerset Bee-keepers' Association and the Bristol branch of the Somerset Bee-keepers' Association.
The Bristol Post Office Retired Officers' Association.
The Whitehall and District Allotments, Ltd.
Wiltshire County Party.
Devon Farmers' Party.

Educational exhibits were staged at the following Shows :—

The Royal Agricultural Show, Reading.
The Bath and West and Southern Counties Society's Show, Watford.

The Cambs. and Isle of Ely Agricultural Society, Wisbech.
The Long Ashton Horticultural Society, Long Ashton.
The Somerset County Show, Wells.
The Wiltshire County Show, Chippenham.
The Three Counties Show, Gloucester.
The Imperial Fruit Show, London.
The Brewers' Exhibition.
Abergavenny Horse Show.
The Bedwelty Agricultural Show, Blackwood.

Several lectures have been given by members of the staff both within and outside the Bristol Province. In this connection it is significant to note the increasing interest being taken abroad as well as in this country in the work the Station is doing. Its development has been apparent from correspondence and enquiries received from all parts of the world and has been particularly emphasised by the visit of Mr. Wallace, the Deputy Director, to America last August, to attend the International Conference on Plant Science held at Ithaca and view representative experiment stations and fruit-growing areas in Eastern Canada and the United States. The visit was made possible by the award of a Travelling Fellowship from the Ministry of Agriculture.

The scheme for the provision of local instruction in cider-making is now in full operation. The counties of Dorset, Monmouth and Worcester are being served by a full-time instructor, Mr. P. T. H. Pickford, who has been trained at the Institute and has his working headquarters located there. The training of Mr. Forshaw, the instructor for Somerset, has also been completed and he is now working exclusively in that county. The position in the other interested counties is similar to that a year ago, except that in Devon more particularly a strongly supported organised effort to improve the present position of farm orcharding in the county and to secure the planting of a large acreage of new cider orchards has developed. A similar movement in other counties is foreshadowed.

The more advanced course of cider instruction proposed to be given at the Institute has been started. Owing to lack of available laboratory accommodation the number of pupils has had to be limited, but by the autumn of 1927 it is expected that the new laboratory extension will be finished and as much room as is likely to be required will then be available.

As part of the effort to stimulate greater interest among farmers in their orchards and ensure adequate supplies of English-grown cider fruit for the future, a new departure in the cider-house work at the Institute in the shape of a novel form of cider competition was started during the cider-making season 1925-26. Further details of this are given in a later section of this Report. The Institute is greatly indebted to the judges, Messrs. Herbert J. Davis,

W. Chapman Gaymer, and R. E. Ridler, for their services, which were given free of expense to it, and desires to place on record here its appreciation and thanks. Their task was a novel and difficult one, and it must be a source of gratification to them that their awards met with general approval.

The relations of the Institute with other centres and conjoint work arranged with those bodies were recorded in some detail in the 1925 Report. There is no occasion to repeat the record here, since in all cases corresponding arrangements were continued throughout 1926. It will suffice if mention is made of the following features.

The second joint meeting of the staffs of the East Malling and Long Ashton Research Institutes was held at the former Station in November. Our thanks are due to the Director and Staff of that Institute for the hospitality received on that occasion and the excellent arrangements which ensured a most useful and instructive visit.

The third joint meeting of the research, educational and advisory workers in the Harper-Adams and Bristol Provinces took place in June, part of the time being spent at Bristol and Long Ashton and the remainder at the Somerset County Agricultural Society's Show at Wells.

The original fruit soil survey undertaken in conjunction with a group of workers attached to the Agricultural Department of the University of Cambridge has been completed. A detailed report covering the whole of the work accomplished during the four-year period over which the survey extended has been prepared and submitted to the Ministry of Agriculture. The results, which are of fundamental importance, will probably appear among the series of Research Monographs issued by the Ministry. An abbreviated account is included in the present Report. The second survey, to which preliminary reference was made a year ago, has been started and promises to provide results of the same order of importance as its predecessor.

Meetings of the workers engaged on the investigations on the strawberry problems took place at the Seale Hayne College in July, and at the Ministry of Agriculture in December, to discuss progress. The situation has been cleared considerably and some six or seven characteristic forms of diseased or unhealthy plants can now be identified in the field with some degree of certainty and in certain cases associated with a specific cause. Progress has been slower than had been hoped, since the services of a suitable full-time investigator could not be secured. The work has, therefore, been entirely in the hands of workers who have had other calls on their

time. Unfortunately, the prospects of carrying through completely the 1927 programme are even less favourable, for it is probable that the services of two of the most active workers will no longer be available.

Berkeley Square Advisory Centre.

During the year 1926 considerable progress may again be reported in certain branches of the advisory work. The following new appointments were made to the Agricultural Advisory Staff at Berkeley Square, Bristol—Mr. V. L. S. Charley, B.Sc., has been appointed as a full time Chemist to work with the Advisory Chemist; Mr. M. C. Thorne, P.A.S.I., and Mr. G. H. Pickard, P.A.S.I., have been appointed Student Assistants in Agricultural Economics.

The co-operation existing between the Advisory Officers and the County Staffs has been still further cemented by the initiation of joint experimental work on spraying of fruit trees, grass land problems, sugar beet experiments and work in connection with the County Clean Milk Competitions. For the purpose of co-ordinating results of experiments it becomes more and more necessary to run the experiments on co-operative lines, and in most cases they are designed so as to contain certain plots or treatments common to every series, in whatever district or county they may be situated, at the same time allowing a certain amount of elasticity in the use of optional treatments.

Agricultural Chemistry. Whilst the number of samples of manures, feeding-stuffs, etc., in connection with general agricultural questions has shown a further increase over previous years, a good deal of special work had been carried out in connection with the sugar beet crop. Upwards of 300 samples of sugar beet have been dealt with in the laboratory and the Advisory Chemist, as a member of the Sugar Beet Sub-Committee of the Agricultural Education Association, has been devoting considerable time to problems in connection with this important crop.

Of the general farming problems grass land is still of paramount importance and continues to monopolise more of the work in this section than any other farm crop.

Dairy Bacteriology. The abnormally large entries in the County Clean Milk Competitions in Somerset and Wiltshire led to a large increase in the amount of bacteriological work carried out during the winter, 1925/1926. Unfortunately, the outbreak of "Foot and Mouth" disease seriously interfered with the Competitions in all our counties except Somerset. It is gratifying to note that advisory work on questions in connection with the production of "clean

milk " and in milk bacteriology generally increased greatly during 1926. Quite a number of producers of graded milks now avail themselves of the opportunity of having samples tested regularly by this department.

Agricultural Economics. The completion of a full year's cost accounts and the examination of a full year's financial accounts on many farms, particularly in Somerset, has enabled Mr. Weller to establish a distinct advance in the Agricultural Economics work during 1926. In connection with the cost accounts a somewhat unique meeting took place at the University in November, when eight farmers met the Vice-Chancellor and members of this Department to discuss fully the details obtained during the complete financial year. Some most valuable points in connection with farm management were ventilated and many matters for future investigation were suggested. There is no doubt that for the farmers concerned such a discussion is distinctly superior to lengthy written reports on the year.

At the request of the Somerset County Branch of the National Farmers Union Mr. Weller drew up a summary of the results of his investigation of cost and simple accounts. This evoked considerable interest when read at the annual meeting at Yeovil in December. Copies of the report have been circulated amongst farmers and others interested. At the annual dinner of the Wellington Branch, which Mr. Weller attended, further appreciation of the work in Agricultural Economics was forthcoming.

Another interesting source of farmers' accounts for analysis in this department is provided through the formation of the Wiltshire Agricultural Accounting Society. The formation of this Society does not in any way interfere with any arrangements which may have been made previously with professional accountants and others for the preparation of accounts for income tax purposes, but it facilitates the use of such accounts by this department for the investigation of farm management problems. Mr. Thorne has during the year taken up permanent quarters in Wiltshire in order to be on the spot and to assist more conveniently the work of this Society.

Mr. Weller also formulated a Correspondence Course in Farm Book-keeping, which has been taken up in Wiltshire and in Gloucestershire, and is being conducted successfully by the County Staffs.

Campden Research Station.

The vacancy caused by the resignation of Miss M. J. M. Watson, who has been appointed Inspectress in Domestic Science under the

Scottish Board of Education, has been filled by the appointment of Miss Margaret Adams as Demonstrator in Fruit and Vegetable Preservation.

Dr. F. J. Paton's appointment as Assistant Research Chemist at Campden terminated at the end of 1926. A successor will be appointed in the new year.

The educational and advisory work of this Station continues to show rapid advance.

Forty-four students, mainly teachers of domestic science, attended the courses held during the fruit season. The increased number of students for the year was the result of a conference held at the Board of Education and attended by representatives of the Board, the Station and the various Womens' Training Colleges. At this conference the question of courses suitable for teachers of domestic science was considered, and it is probable that these courses will in future be more especially designed to meet the needs of the Board of Education.

There is a significant and increasing demand for courses of training in commercial methods of fruit and vegetable preservation, which under existing conditions at Campden cannot be met. This problem has been under serious consideration and, if certain negotiations now in progress result satisfactorily, may be solved before the next Report is issued.

Eighteen lectures to various local Women's Institutes in counties adjacent to the Station have been given in addition to a few lectures outside the district to special bodies, such, for example, as the Lea Valley Tomato Growers' Association. Three demonstrations of the home canning apparatus introduced by the Station have been held in Warwickshire with an aggregate attendance of 250. The introduction of this machine has evidently supplied a definite want and the makers report that sales have been encouraging.

The number of enquiries for advice and assistance on technical points continues to increase, 576 being dealt with in 1926. While they mostly relate to the domestic side of fruit and vegetable preservation, there has been a notable increase in the number of those relating to the commercial aspect. In fact, the salient feature of the year's work has been the active help rendered to various firms who have undertaken fruit canning for the first time.

In the latter connection special reference may be made to the demonstration of fruit canning organised by the Station in conjunction with the Ministry of Agriculture, at the premises of the British Fruit Packing Co., Ltd., at East Farleigh, near Maidstone. For this purpose the Station was enabled to procure from America

one of the most up-to-date types of canning plant, which was installed at East Farleigh for the primary purpose of serving for demonstrations of apple canning on a commercial scale. The unfortunate failure of the apple crop in Kent caused a drastic curtailment of the original programme with apples, and arrangements are accordingly being made for a continuation next season. On the other hand, the abundant plum crop afforded a very favourable opportunity of demonstrating the canning of that fruit on a commercial scale and consequently the main effort at East Farleigh for the 1926 fruit season was concentrated on that fruit, with very encouraging results. Both in this case, and at other centres where the staff of the Station have given active help in establishing commercial canneries, the results have shown that there is a great demand for British canned fruit of good quality and that the beginnings of what should prove a flourishing industry are being firmly established.

With the object of fostering this young industry steps have been taken during the year by the Ministry of Agriculture which have resulted in the formation of a National Canning Council, a body which is thoroughly representative of the fruit growing, canning, tinplate, can-making and other associated industries. The Station is represented on this Council and its Research Committee by the Director and Resident Director. It has already undertaken a number of investigations and furnished various reports on canning and related problems at the request of the Council, serving in fact as the centre to which the Council looks for help on the technical side.

The Station has also been of service to the Ministry of Health in connection with questions which have arisen on the use of certain preservatives utilised for imported preserved fruit.

The facilities which the Station affords for assistance on matters relating to fruit and vegetable preservation are thus now becoming more fully realised, and it would appear that it is becoming a factor of high value in the promotion of the welfare of the fruit and vegetable industries of this country in so far as it deals with the utilisation of that portion of those crops which cannot be consumed in the fresh state. As its usefulness extends, it becomes increasingly clear that it is desirable to bring it into closest possible touch with the cultural side of fruit and vegetable growing, since the one side is a necessary adjunct to the other for economic reasons. The University and the Ministry of Agriculture have under consideration a scheme whereby this may be affected and important changes designed to achieve this object may come into operation during the coming year.

The applied results of the experimental and research work carried out by the Station have already in some cases been published in a series of leaflets issued by it. Miss Watson has published a handbook on The Home Preservation of Fruit and Vegetables, which embodies the experience gained in the course of the Home Kitchen work at Campden. Other publications relating to the work are in course of preparation.

FRUIT SOILS SURVEYS.

By T. Wallace.

It has long been recognised by practical horticulturists that soil conditions play an important rôle in successful fruit growing. Certain soils, such as the Old Red Sandstone soils of Herefordshire and Worcestershire, the Permian soils of Devonshire and the Ragstone and Brick Earth soils of Kent have been noted as fruit soils for many centuries. Also, whilst certain soil conditions have been recognised as favourable to the growth of fruit trees, others have been regarded as unsuitable.

The soils of fruit growing areas have not been systematically studied, hitherto, in this country. Hall and Russell, in their "Survey of the Soils of Kent, Surrey and Sussex," examined the soils in certain of the fruit growing areas and showed that those usually regarded as especially suitable for fruit growing were, in general, loams containing fairly high proportions of fine sand, silt and fine silt and medium but not high amounts of clay. In virtue of their textures the soils were generally naturally well drained but not likely to dry out too quickly in seasons of drought. These workers give a few examples showing the differences in textures of soils from orchard areas in which fruit trees have been successful and others in which they have been unsuccessful and, although they show that differences exist in the textures in comparable cases, they do not attempt to explain the manner in which the different soil conditions produce the respective results.

During the course of advisory work carried out by the writer in the past, numerous cases have been observed in orchards and plantations of outstanding successes and of conspicuous failures which have obviously resulted primarily from soil factors. Whenever possible, data have been collected of such cases and consideration of these has indicated that it would be possible to correlate certain soil conditions with good and bad growth in fruit trees.

In 1922, the question of the effect of soil conditions on the growth of fruit trees was considered by a Sub-Committee of the Ministry of Agriculture and Fisheries and, as the results of the deliberations of the Sub-Committee, a scheme for investigating the problem was evolved in which this station was asked to participate.

The scheme was briefly as follows :—

It was thought that there existed in the Wisbech area of East Anglia a relatively small area over which several types of soil occurred whereas such factors as climate, altitude, water-table, etc., likely to affect the growth of trees were relatively constant. In such an area it would be possible to study the effects produced by varying soil conditions under circumstances where other factors varied inappreciably.

On the other hand, it was thought possible to select areas in the West Midlands over which similar soil conditions obtained but where the factors, climate, water-table, altitude, etc., showed significant differences.

The two problems were regarded as complementary. The Horticultural Department of the School of Agriculture of Cambridge University was asked to undertake the investigation in East Anglia and Long Ashton Station that in the West Midlands.

In the latter district two areas were finally selected, the first being the relatively large and important fruit growing area occurring on the Old Red Sandstone marls around the town of Bromyard in Herefordshire and including such famed areas as those of the Teme Valley, Suckley, Ledbury and Aston Ingham and the second the smaller area of light soils situated around the town of Ross.

The investigations have been completed recently and detailed reports have since been prepared on the findings.

It is sufficient to state at this point that the results have shown that in both areas a close correlation exists between soil conditions and tree growth and that such surveys possess great value to the fruit grower. These surveys are discussed further below.

In consequence of the character of the results obtained in this preliminary work, the Ministry of Agriculture has decided to extend the investigations to other areas and has allocated to this institute a special grant for the continuation of the work.

Since the allocation of this grant, work has been commenced on the fruit growing areas situated on the Lower Lias formation in Worcestershire, Gloucestershire and Somerset. The more important of the fruit areas in these districts are those located in the neighbourhoods of Evesham, Pershore, Cheltenham and Martock. This particular formation has been chosen for two reasons. In the first place the districts occurring on it are of great importance for fruit growing and, secondly, the soils occurring in them are either clays or gravels. Thus, when the investigations of these are completed data will be available relating to the following

classes of soils—coarse gravelly soils, coarse sandy soils, close textured fine sandy or silty soils and heavy clay soils. The data from such soils should provide valuable information on the problems likely to be encountered on most classes of soils utilized for fruit growing.

Since these surveys are likely to form an important feature of the programme of work of the station during the next few years, it seems desirable at the present stage to make known the aims and possible uses of them, to say something of the methods of working and of the character of the results obtained to date and of the manner in which it is proposed to publish the results to bring them within the reach of growers.

Aims.

The three main aims of the work may be stated as follows :—

1. To determine the part which soil conditions play in successful fruit growing in the chief fruit growing areas in the West Midlands. An attempt will be made to correlate various soil factors with tree growth, behaviour as regards fruiting, fruit quality, incidence of diseases, etc.
2. To discover what are the particular problems due to soil factors in each area and to investigate the manner in which these factors operate and the nature of the effects they produce.
3. To classify the various soil conditions occurring in each area and eventually to construct soil maps of the areas.

It should be stated that in the earlier stages of the work it is not proposed to make detailed soil maps as the construction of such maps is extremely slow work and in many areas their value to the practical man is not very great. It is considered important for present needs to describe accurately the different soil conditions occurring in the areas and the practical effects of these on tree performance and hence it is proposed to follow this procedure at the present stage of the work.

Uses.

As stated previously, it is considered that these surveys are of great practical utility. A list showing the more important purposes which they may be expected to serve is given below.

1. For advisory purposes :—They will provide data which will enable Advisory Officers to furnish valuable advice in cases where they are requested to give opinions on the suitability of land for fruit growing purposes.

Plate I. Bush apple trees, variety Lane's Prince Albert, age 20 years, growing on a Class A. soil area in the Bromyard area.

Plate II. Bush apple trees, variety Lane's Prince Albert, age 20 years, growing on a Class B2. soil adjoining area in Plate I.

2. To enable growers to recognise the nature of the problems in their plantations.

3. To serve as a basis of determining the soil problems occurring in the areas considered and in other areas where similar soil conditions occur. Certain results in various areas can be reasonably expected to be applicable to similar soil areas—*e.g.*, areas of light sandy soils provide certain problems in common.

4. To provide a basis for further technical investigations—trials of stocks and varieties, manurial trials, systems of management, etc.

The manner in which the results can be applied in these and other ways will become evident when the results obtained to date are considered below.

Methods of Working and Character of Data.

It will be of interest to growers to know something of the methods of procedure adopted in carrying out the surveys and of the character of the data collected. The work is divided into three sections—soil investigations, pomological investigations and cold storage tests on fruits. In the initial stages of a survey the field characters of the soils in plantations and orchards of the area are examined and representative samples of soil are collected to varying depths, according to the soil conditions found, for examination in the laboratory. These samples are examined to determine the following points : texture or mechanical composition, chemistry and mineralogy. As the result of the field and laboratory work the soils are eventually classified.

In the field examination special attention is paid to good and bad growth areas, sites, drainage features and systems of soil management, including cultivation, cropping, manuring, etc. Details of acreage are recorded and general notes are made on the classes of fruit and varieties growing on the areas.

The soil worker is followed by the pomologist who takes detailed records of the various pomological features occurring—classes of fruits, varieties, behaviour of the various kinds of trees and bushes, growth features, fruitfulness, fruit characters, distribution of pests and diseases.

The soil and pomological data are subsequently considered together, and the various correlations existing between soil and other factors and the pomological features are determined.

In connection with the work on fruit quality, arrangements have been made with the Food Investigation Board to carry out cold

storage tests on certain varieties of apples to determine the effects of soil conditions on keeping quality.

The various correlations having been determined, attention is given to the major problems of the areas and especially to cases of failure which, while of frequent occurrence, appear likely to be substantially improved by appropriate treatment. Examples of such cases can be quoted in the cases of the completed surveys.

Records and Publications.

The questions of records and publication of results call for special mention in this article as there are a few points in connection with these to which it is desired to draw the attention of growers whose plantations may be examined during the course of the surveys.

In the first place we realise our great indebtedness to growers for permission to examine their plantations and for the large amount of valuable information which is always forthcoming in answer to our numerous enquiries. All information obtained is always treated as being *strictly confidential* and we wish to take this opportunity of assuring growers who co-operate in this work that all knowledge gained of plantations and orchards in these surveys will always be treated as confidential and that information regarding any plantation or orchard will not be given to anyone excepting to the owner or tenant concerned without permission being given previously by the appropriate person. On the other hand, we shall always be prepared to furnish as complete a report as possible on any plantation or orchard to those immediately concerned.

Since the information on individual plantations is regarded as confidential, it is necessary to publish the results without reference to names and it is proposed to accomplish this by means of assigning numbers to plantation areas and by placing a confidential key to these for the use of Advisory Officers in the station files at Long Ashton.

Two types of reports will be drawn up for each area. The first will be a detailed report of the work carried out and the conclusions reached and will contain all the data amassed in the form of appendices. These reports will not be suitable for general circulation in view of the prohibitive cost of publication but will be available for reference at Long Ashton and in the Agricultural Offices of the Counties concerned. The second type of report will possibly be in the form of a monograph published by the Ministry of Agriculture and Fisheries and will be published at as low a price as possible. In this publication much of the detailed data contained in the appendices of the detailed report will be cut out, only appropriate examples from these being given to supplement the text.

A full description of the work done and of the conclusions arrived at will be given and every attempt will be made to present the subject in readable form. The volume will contain appropriate illustrations.

In connection with the surveys which have already been completed in the Bromyard and Ross areas it should be stated that copies of the detailed reports of these have already been forwarded to County Agricultural Organisers of Hereford, Gloucester and Worcester for office use and information on the results will be available in the future from the above officers or from Long Ashton authorities.

The question of the publication of the abridged reports is at present receiving the attention of the Ministry of Agriculture.

*Bromyard and Ross Areas Surveys.**

In order to illustrate certain of the points dealt with above it is proposed to conclude this paper by presenting a brief summary of the work carried out in the Bromyard and Ross areas and referring to some of the more salient features of the results and their practical importance.

BROMYARD AREA.

The area considered covers approximately 200 square miles and is mostly enclosed in the roughly rectangular area formed by lines joining Berrington Mill, Worcestershire, in the north west; Stockton-on-Teme, Worcestershire, in the north east; Ledbury, Herefordshire, in the south east; and Holmer, Herefordshire, in the south west. The remainder of the area is comprised of a narrow strip, only a mile or two in width, extending from Ledbury, Herefordshire, in the north to Underdean, Gloucestershire, in the south.

The soil of the area is in general a close-textured silty loam, generally devoid of stones and underlain by marl, and from its working properties is classed as a heavy soil. It is a sedentary soil derived from the underlying rocks which belong to the Lower or Cornstone division of the Old Red Sandstone formation. These rocks are composed chiefly of clays, marls and cornstones with occasional bands of close-textured soft micaceous sandstone.

The area is hilly and plantations and orchards are located on a variety of sites at altitudes varying from 200 feet to 500 feet above sea level. It has been a noted fruit growing area for several centuries and at the present time many excellent orchards of apples, cherries, plums and damsons are distributed over it.

* By T. Wallace, G. T. Spinks and E. Ball.

During the course of the survey 44 centres were visited and the soil conditions were examined in 115 plantations and orchards. As a definite problem was involved in this survey only those orchards and plantations were examined which were judged as suitable for the purpose in view. The acreage considered was 743 acres and 320 soil samples were selected for laboratory determinations. As the result of the soil work the soils of the plantations examined were subsequently placed into classes as follows on the basis of certain field characters and of texture features revealed by mechanical analysis.

Class A.—*The Predominant Class of the Area.*

Surface soils are close textured silty loams, pink in colour when dry and brick red when wet. Stones are generally absent but a small percentage of sandstone fragments or cornstone nodules may be present. The soil, when moist, samples easily with an auger and it is usual to find the successive layers of subsoil are more clayey than those immediately above until finally the typical stiff marl of the parent rock is reached. The gradation from the close textured surface soil to the marl at a depth below 30ins. is a characteristic feature of the group.

Of the mechanical fractions, fine gravel and coarse sand usually comprise less than 5 per cent. fine sand, silt and fine silt are important fractions and clay ranges from 8.5 per cent. to 17.5 per cent. whilst at 18ins. to 30ins. depth, this fraction constitutes from 12 per cent. to 22 per cent.

Class B.

This class includes several sub-classes or divisions exhibiting characters which differentiate them from Class A.

Division B1.—*Special Feature: The development of stiff bands of marl at or near the surface.*

The condition is usually met with on knolls or portions of slopes where the curvature is convex. It is doubtless the result of active periodic erosion of the surface soil layers. The bands are impervious to water and mark the lower limit of weathering effects. The surface soils are usually of closer texture than Class A. and the marl layer contains a high percentage of clay.

Division B2.—*Special Feature: Shallow soil overlying unweathered material of a fine sandy or silty character.*

These conditions generally occur under the same circumstances as B1. and are most probably due to the same agencies. The unweathered material *in situ* is impervious to water, but when

excavated and placed in water it easily falls to pieces. The structure of the profile of this material is " platey." The impervious character appears to be due to the absence of coarse particles and to the shape and arrangement of the particles. There is no iron pan present.

The soils may show any one of the following " irregular " features in proceeding from the surface soil to the depths of 30ins. to 42ins.

a. Sharp rise in " fine sand " accompanied with a fall in clay.
b. „ „ „ silt „ „ „ „ „ „
c. Irregular decreases in the clay fraction only.
d. Sharp rise in the " fine sand " only.
e. Decided fall in " fine sand " with sharp rise in " fine silt."

Division B3.—*Special Feature*: *Sandy pockets of loosely packed particles which offer little resistance to the auger.*

These pockets often occur near the outskirts of areas as in B2, and are possibly formed from the natural panning of coarser particles in the formation of the particular condition in B2. The surface soils have textures as in A. Abnormal material occurs which contains a high percentage of " fine sand."

Division B4.—*Special Feature*: *Shallow soil of stiff marly character overlying cornstone deposits.*

This condition occurs in situations as in B2 and is very similar to it. A point of difference is the character of the underlying rock.

Division B5. –*Special Feature*: *Shallow soil overlying soft sandstone rock.*

The surface soil may be close textured as in Class A. with a more sandy subsoil or it may be sandy and contain fragments of sandstone rock. In the more extreme sandy cases the soil may contain 60 per cent of fine sand, whilst the percentage of clay is much lower than in class A.

Division B6.—*Special Feature*: *The soil from the surface to 30ins. depth or more is of a light fine sandy nature.*

These areas generally occur in the vicinities of sandstone outcrops. The soil to 30ins. is much lighter than in group A. Fine sand is high, silt and fine silt tend to be low and clay is always low.

On the completion of the pomological work the trees and bushes growing on the various soil areas were grouped into four classes. The characters of these groups are as follows :—

Group 1. Good, well-grown and fruitful trees.

Group 2. Trees which apparently have been good but are now aged and those which would also be good but for certain points in their management.

Group 3. Medium trees ; inferior to those in group 1 as regards growth, health and cropping.

Group 4. Bad trees ; stunted or dying.

The relationships found between the pomological groups and the soil classes are summarised in Table I.

TABLE I.—SHOWING THE RELATION BETWEEN SOIL AND POMOLOGICAL GROUPS.

Tree Groups.	Number of Cases.	Soil Groups.						
		a.	b.					
			1.	2.	3.	4.	5.	6.
1	52 + 2* = 54	47					4	1
2	39 + 2* = 41	38						1
3	11 + 1* = 12	4	1	3		2		1
4	46 + 0 = 46		2	26	4	4	9	1
Totals	153	89	3	29	4	6	13	4

* Denotes soil not examined.

The cases considered in this table are mostly apples, the remainder being plums, damsons and cherries.

The results show that there is a striking correlation between the soil characters considered and tree growth. Practically all the highly successful trees occur on Class A. soil conditions. The exceptions occur in the cases of Classes B5 and B6, and in these cases the trees in question are cherry trees ; apple trees on such soil areas are not successful. It is also clear that certain soil classes are invariably associated with failures or poor results as in Class B2.

Typical examples of apple trees growing on adjoining areas where soil condition of Class A. and Class B2 categories obtain are shown in Plates I and II.

ROSS AREA.

This area comprises a few square miles around the town of Ross, in Herefordshire. The soil, other than on the alluvial tract bordering the river Wye which flows through the district, is generally

of a coarse textured sandy nature. It is derived from the underlying rock which is a soft grained sandstone containing quartzose grits and exhibiting much false bedding. Occasional lozenge shaped bands of marl occur between the layers of sandstone.

The surface of the area is of an undulating character and its continuity is broken by the river Wye which flows through it for the most part in a fairly deeply cut bed. Outside of the river valley the altitude of the land varies from 200ft. to 300ft.

The soil of the district is highly prized for arable crops but the district does not appear to have any great history as a fruit area as is the case of the Bromyard area.

The soil conditions occurring in the fruit plantations of the area were classified as follows :—

Class A.

The surface soil and subsoil are of a coarse sandy texture, are pink in colour when dry and brick red when wet. The sandy material overlies a bed of red marl which occurs at depths varying from 15ins. to 3ft. 6ins. The appearance of the marl is similar to that occurring in the Bromyard area.

Class B.

The surface soil and subsoil are mixtures of coarse sand and marl and are appreciably stiffer than the sandy soil in Class A. The subsoil rests on soft sandstone rock.

Class C.

Surface soil and subsoil to at least 4ft. 6ins depth consist of coarse sandy material as in the surface soil of A. Marl is absent.

Class D.

The surface soil and subsoil (where present) consist of coarse sandy material as in A. and overlie soft sandstone rock which occurs within 30ins. of the surface.

The pomological data allowed of the trees of the area being arranged into four groups as shown under the Bromyard area.

The relationship existing between tree growth and soil characters is shown in Table II.

TABLE II.—SHOWING THE RELATION BETWEEN SOIL AND POMOLOGICAL GROUPS.

Tree Groups.	Number of Cases.	Soil Groups.			
		a.	b.	c.	d.
1	6	4	2		
2					
3	3	1		2	
4	10			4	6
Totals	19	5	2	6	6

From the table it is quite clear that here again a close correlation exists between certain soil conditions and tree growth, the trees considered in this case being apple and plum trees.

Successful trees occur on soil areas A. and B. (no cases of the latter are given in the table), whilst failures are associated with soil groups C. and D.

Examples of typical specimens of apple trees growing on adjoining areas of the types in soil Classes A. and C. respectively are shown in Plates III and IV.

The above examples from the Bromyard and Ross areas will serve to show the kinds of results which the surveys may be expected to yield.

One further point requires mention in illustration of the practical utility of the results. Certain soil conditions in the two areas having been found to be almost invariably associated with tree failures, it becomes a matter of importance to discover whether the causes of the failures can be remedied. Experiments with this end in view have been commenced on areas where various remedial measures appeared worth trial and already results have been obtained, which suggest that in certain cases in the Bromyard area, in Classes B5 and B6, and in the Ross area in Classes C. and D., the difficulties may be overcome by appropriate treatments.

AN EXPERIMENT ON THE WINTER-KILLING OF VEGETABLE CROPS IN MARKET GARDENS.*

By T. Wallace.

The experiment described in this paper was carried out as the result of an enquiry submitted to the writer by the Bristol and District Association of Market Gardeners on the occasion of a lecture given before that Association in November, 1923.

On that occasion the statement was made by several growers that they were no longer able to produce satisfactory winter crops in their gardens owing to the fact that the plants were killed during the periods of cold weather which occured during the winter months.

The writer undertook to investigate the problem and the necessary facilities were placed at his disposal by members of the association.

A preliminary examination showed that the problem bore little relation to the original soil types of the gardens as plants appeared to be equally affected on soils as widely different as those derived from the light Pennant sandstones and the tenacious Lower Lias clays. In all cases where winter-killing occurred the land had been under continuous market garden cropping for a number of years—from ten years and upwards—and the information was obtained that plants were never affected on new land.

Plants growing on these old garden soils during the winter months invariably showed exceedingly poor root development and there was always a lack of fine fibrous rootlets. They could generally be pulled out of the ground without appearing to offer any resistance, thus showing that the roots had a very poor hold in the soil.

In broad-leaved plants such as cabbages and lettuces the marginal portions of the leaves always exhibited a scorched appearance, whilst the foliage of onion plants showed symptons of dying back from the tips.

Similar symptons were observed on cabbage plants and lettuce plants in some of the gardens during a dry period of summer weather.

The regular practice in the gardens is to grow such crops as celery, marrows and various brassicæ during the summer months and to

* Reprinted from "Journal of Pomology and Horticultural Science," Vol. v. No. 3, July, 1926.

follow these with winter onions, winter lettuces and spring cabbages, etc., for the winter months.

The system of manuring followed is to apply very heavy dressings of town stable manure to the summer crops—from forty loads per acre upwards—as it is the opinion of the growers that without such heavy dressings of stable manure satisfactory results cannot be obtained with celery and marrows.

Of late years much trouble has been experienced from fungus diseases on the celery crop in many gardens and hence it has become increasingly important that a successful winter crop should be obtained. In some cases the position has become so acute that the growers are contemplating giving up their old grounds and moving further into the country.

Description of Experiment.

A typical piece of land for the purpose of carrying out experiments was kindly offered by Mr. W. T. P. Hasell, at St. George, Bristol. The ground had been under market garden crops for forty years. Previous to being taken over for market garden purposes the soil was a very tenacious Lias clay soil which could only be dug over with a fork with great difficulty.

During the whole of the period that the land has been under market garden crops the practice has been to apply extremely heavy dressings of town stable manure and frequent dressings of lime and as a result of this treatment the soil has lost its original clay properties and now works like a light soil and is inclined to be " puffy." Indeed, the physical properties of the soil now appear to be determined almost completely by the high content of organic matter.

The garden was visited on December 5th, 1923, to examine the condition of plants in the winter state and to select a piece of land for experimental purposes. On this occasion, on certain plots in the garden, spring cabbage plants and winter lettuces were exhibiting the typical symptoms to a marked extent, showing marginal scorching of the leaves and deficient root development. The root systems of some of these cabbage plants were compared with some plants which had been raised in the same seedling bed and planted out on a new piece of ground and it was noted that the latter plants had well developed fibrous roots and healthy foliage.

A border planted out with winter lettuces was selected as suitable for the purpose in view. The plants on the border were in very poor condition, a large proportion appearing to be practically dead, and the grower was of opinion that another period of cold weather would kill most of the plants.

Two plots were marked out on the border for treatment. A composite sample of soil, to a depth of 9 inches, was taken from the border. The percentages of carbonate of lime and available potash and phosphoric acid were determined in the sample. It was proposed to carry out further determinations but, unfortunately, the sample was mislaid in the laboratory.

The results obtained were as follows :

	%
Carbonate of Lime	5.85
*Available Potash (K_2O)	0.0410
*Available Phosphoric Acid (P_2O_5) ..	0.1838

* Denotes soluble in 1% Citric acid solution.

To one of the plots, which measured 40 yards by 5 yards, it was proposed to apply regular dressings of sulphate of potash to subsequent crops, whilst the remainder of the border was to be given no manure of any sort.

The reason for suggesting these treatments was that the writer, in his experiments on the nutrition of fruit trees, etc., (1, 2) has found that when plants are fed with nutrients in which the ratio nitrogen to potassium is very wide the trees become affected with leaf scorch and the root systems formed are frequently deficient in fibre. In field experiments on gooseberries at this Station it has also been demonstrated that such feeding may actually prove so detrimental to growth as to actually reduce the condition of the plants below that of the plants on the unmanured plots.

It is generally held by growers that stable manure, being a natural manure, is a sufficiently well balanced manure, but in the writer's opinion, for horticultural purposes where large dressings are given regularly, this is not the case, such a practice leading to a condition of excess nitrogen in the plant food.

The programme of cropping and manuring arranged for the first season was as follows :—

The lettuce crop occupying the plot was to be followed by Seville beans as the 1924 summer crop, and the beans by winter onions for the 1924-25 winter crop. A dressing of sulphate of potash at the rate of 3 cwts. per acre was to be applied without delay to the lettuce plants on the " treated " plot and a similar dressing was to be applied to that plot at the time of the planting of the onions. The programme was carried out in its entirety.

Results.

The effect of the potash dressing on the lettuce plants was not examined by the writer as it was thought that the plants were in

too poor condition at the time of applying the dressing to derive any benefit from it. The grower, however, was of opinion that the plants showed some response to the treatment.

Observations on the bean plants during the early stages of growth were carried out by the grower, who stated that differences in favour of the potash plot plants were evident from an early date.

The plots were inspected by the writer on June 26th at which time the stage of the first picking over had been reached. On that date it was quite evident that the condition of the plants on the potash plot was superior to that of those on the unmanured plot. On the latter plot the foliage was in poor condition, many leaflets were of an unhealthy green colour and exhibited pale marginal markings and blackened patches. The plants were also fairly badly affected with " Chocolate Spot " disease. On the potash plot the foliage was a much fresher green than on the unmanured plot, there being practically no signs of the pale bands or the blackened patches on the leaflets. The plants did not appear to be suffering from " Chocolate Spot " to anything like the same extent as those on the untreated plot.

Owing to the difference in condition of the plants on the two plots the grower was obliged to clear the crop on the untreated plot before that on the potash plot.

As with the bean plants, the early observations on the onion crop were carried out by the grower and these observations again showed that from an early stage the plants on the potash plot made better growth than those on the unmanured plot.

The plants on the latter plot showed the typical deficient root systems, whilst on the former plot the root growth was normal in character. By December, plants on the untreated plot began to die off and it became necessary to commence clearing off some of the better plants on the plot to sell " bunched green " as it was obvious that the plants would otherwise be lost. The plants on the portion of the plot adjoining the potash plot were left untouched for comparison with the plants on the latter plot.

The plots were inspected by the writer on December 22nd. On the potash plot there was a normal " stand " of healthy plants. The root systems were well developed and the tops were about 12 inches in height. On the untreated plot the " stand " was very irregular, there being numerous bare patches where the plants had died out entirely. The best plants on this plot were also considerably behind the average plants on the potash plot. The difference in the development of the plants on the two plots was very marked.

Photographs of the plots, showing the condition of the plants, were taken on January 23rd, 1925. These are reproduced in Plates I. and II.

PLATE I.

Showing the condition of the onion crop on the potash treated plot on January 23rd, 1925. Note the normal "stand" obtained and the vigorous condition of the plants.

PLATE II.

Showing the condition of the onion crop on the untreated portion of the border on January 23rd, 1925. The vacant strip along the edge of the border had been cleared. Note the thin "stand" and the poor condition of the plants.

Discussion of Results.

In this experiment it was quite clear that both the bean crop and the winter onion crop responded markedly to the dressings of potash and that in the case of the latter crop the characteristic symptoms attending winter-killing were overcome by the treatment, as a normal " stand " of healthy plants with well developed root systems was obtained.

In view of these results the writer would suggest that winter-killing of crops in such soils is largely due to the wide ratio of nitrogen to potassium in the plant food resulting from the practice of continuous manuring with heavy dressings of town stable manure and would recommend that growers experiment with systems of manuring using smaller dressings of town stable manure supplemented with dressings of potash manures instead of continuing with their present manurial practice.

Summary.

1. The problem of the winter-killing of vegetable crops in market gardens in the district around Bristol is discussed in relation to the current manurial practice.

2. The results of a manurial experiment designed to throw some light on the cause of the phenomenon are presented.

3. A recommendation, based on the results obtained in the experiment, is made that growers should experiment with systems of manuring entailing the use of smaller dressings of town stable manure than at present, supplemented with dressings of potash manures instead of continuing in their present practice of relying wholly on large dressings of town stable manure.

References.

(1) Wallace, T. Pot Experiments on the Manuring of Fruit Trees. Annual Reports, University of Bristol Agr. and Hort. Research Stn., 1921, 1922, 1923.

(2) Wallace, T., and Hutchinson, H. P. Note on the Root Systems Developed by Willow Cuttings in Nutrient Solutions. Annual Report, University of Bristol Agr. and Hort. Research Stn., 1924.

PROGRESS REPORT ON FRUIT BREEDING.

By G. T. Spinks.

During the past year the work on fruit breeding at Long Ashton has been confined to observations on the various seedling plants growing in the plantations. Young seedlings have been raised from seed obtained as the result of crosses made in 1925, but no further supplies of seed have been obtained in 1926.

The progress of the work on the various fruits is given under separate headings below :—

Apples.—Large numbers of seedling apple trees are now coming into bearing. Blossom was noted this year on 400 trees, representing approximately 350 different individual seedlings, as some of the seedling trees had been duplicated by budding. Fruit was obtained from 200 different individuals, the size of the crop varying from single apples up to a bushel or more in some cases. Descriptions of the fruit from each seedling have been made and the chief points of interest regarding the trees themselves, such as habit, vigour and health, are also being noted. Time did not permit, however, of the notes on all the fruiting trees being completed this year. The descriptions of each individual tree and its fruit will, in a few years time, provide material from which information on the genetics of the apple may be obtainable ; but at present the number of individuals fruiting in any one family is too small to afford much information.

While making observations on the fruit, any varieties which seemed likely to be of value were noted. Several good apples of different seasons have been found, some suitable for dessert and others for culinary use, but it is doubtful whether most of them are superior to the best varieties now commonly grown. Two seedling varieties, however, appear very promising as early dessert fruits. They are of good dessert quality and are in season only slightly later than Beauty of Bath. One, at least, has every appearance of being a heavy cropper. These two varieties are being propagated for a more extensive trial. Other promising sorts will probably be observed for one or two more seasons before it is decided to propagate any of them.

Plums.—About 30 plum seedlings blossomed this year, but in some cases the amount of bloom was very small. Weather conditions were unfavourable for setting, only 14 trees set fruit, and

finally a crop was obtained from 6 trees only. Plum trees and fruit are being described and selected in the same way as the apples. One of the plums, a rather small mid-season variety which is a good cooker, is worthy of further consideration on account of the extremely heavy crop which the tree bore. This variety is being propagated.

Black Currants.—The plantation of 1,300 seedlings referred to in the Report last year bore its third crop this year and a final selection was made of the bushes which are to be propagated for further trial. The rest of the bushes have now been discarded. Cuttings had previously been taken from most of the selected bushes and a supply of bushes is being worked up. A trial plot of these selected seedling varieties will be planted as soon as possible, and bushes of a pure strain of Baldwin will be included in the trial for purposes of comparison.

Gooseberries.—Observation of seedlings and the selection of any of outstanding merit have been continued.

Raspberries, Blackberries and Hybrid Rubi.—Trials of previously selected seedling raspberries are being continued.

Two families of seedlings derived from crosses between successful commercial varieties of raspberries fruited this year. The parents of one family were early varieties and those of the other were late-fruiting varieties. Several promising seedlings from these two families have been selected for further trial. Seedlings from crosses made later than the above have not yet fruited but have now been moved from the nursery to their permanent quarters.

The various hybrid seedlings to which reference was made last year have also been planted out this winter and have not yet fruited.

The selected seedling loganberries and blackberries appear again to have borne out their early promise. They have, however, up to the present fruited only as individual plants or in very small numbers. They have now been propagated from tips and a sufficient number of young plants from these tips are available for the commencement of a trial on a larger scale.

Strawberries.—Various circumstances combined to make the crop on the strawberry seedlings this year of little value as a test of their true capabilities, and it has been necessary practically to ignore this season's results and to plant out a fresh trial plot of the selected varieties. Adverse conditions, however, have shown which varieties can be eliminated from further trials as lacking in constitution.

A few families of seedlings from which selections had not previously been made were under observation and a few plants were selected for propagation.

THE CORRELATION BETWEEN SOME CHARACTERS OF PROGENY AND PARENT IN THE STRAWBERRY.

By E. Ball.

Of recent years a certain amount of the failure of strawberry fields (decrease in crop) has been attributed to deterioration of strain. In these cases the plants have not been so vigorous as formerly and consequently the crop has been poor, and the plants not so prolific of runners. Some attempts are now being made to raise " regenerated " or " improved " strains by means of selection, the supposition being that deterioration is due to (1) an increase in the proportion of plants infected with some disease, possibly a virus, (2) weakening of the plants by environmental conditions, *e.g.*, poor cultivation and manuring, and taking too many runners from impoverished stocks after the war, and (3) the possibility that as in the case of some other crops the yield can only be maintained by means of constant selection The last case might be due to the occurrence of bud-sporting among a population of strawberry plants. In a progress report in the Long Ashton Report for 1925, the writer gave an account of the work in progress at Long Ashton, in the investigation of strain differences. Some results have been obtained in one line of investigation which seem to be of sufficient interest for publication, the subject being the relation between certain characters of the parent and those of its progeny.

The Investigation.

In 1925 a block of maiden strawberry plants (variety Royal Sovereign) was selected and kept under close observation for a whole season, notes being made on the characters of each individual plant at regular intervals. At blossoming time a number of the plants were selected as parents, the parents being chosen as exhibiting the following characters :—

(1) Differences in vigour.
(2) Differences in the proportion of blossom to foliage.
(3) " Blindness " or absence of blossom.

I. *Vigour of the Parent.*

The selected parents were placed in three classes, viz. : those of strong, medium and weak vigour. The runners from these were hand laid and in some cases only four first runners, *i.e.*, runners next to the parent plant on the stolons, were taken whilst in others an unlimited number of runners were allowed to root, not only first

runners being taken. These runners (800 in number) were raised and planted in September, 1925. Notes were made on the vigour of the runners at the time of planting, and each individual plant was afterwards kept under close observation. Records were made at intervals on the vigour and health of the plants, and at the cropping season, the number of "berries" obtained from each plant was counted. From this material the following data have been collected in tabular form, the unlimited runners being considered separately from the limited or restricted runners. Great variation in the vigour of the plants was noticeable on the plot.

TABLE I.

(VARIETY ROYAL SOVEREIGN.)

PARENTS.		PROGENY.			
		a Weak. *b*		Medium.	Strong.
Weak ..	Limited	32%	(18%)	39%	11%
	Unlimited	60%	(36%)	4%	—
Medium	Limited	20%	(10%)	50%	20%
	Unlimited	30%	(16%)	48%	6%
Strong	Limited	9%	(4%)	49%	38%
	Unlimited	5%	(5%)	57%	23%

a — Weak surviving progeny.
b — Progeny which had died.

In Table I the progeny of strong, medium and weak parents, have been classified at cropping time according to their vigour, in three classes, strong, medium and weak. Unlimited runners are considered separately from limited runners. In this connection it will be seen at once that the effect of the limitation of the number of runners formed has been to enhance the vigour of the plant obtained. In comparing unlimited and limited runners from strong, medium and weak parents respectively, the percentage of strong plants obtained has been increased considerably, viz.: from strong parents from 23% to 28%, from medium parents from 6% to 20% and from weak parents from 0% to 11%. The other point revealed by this table is that strong parents yield more strong progeny than do those of moderate vigour, and those of moderate vigour than do those which are weak. This, however, does not necessarily mean that there is any genetical difference between a strong and a weak parent. Vigorous parents throw more runners and commence runner formation earlier than do weak ones. The fact recorded above, viz. : the decrease in the vigour of the plants obtained by allowing

unlimited runners to root also has a bearing on the subject. This, however, raises the question as to whether a correlation can be shown between the vigour of the parent, the vigour of the runner at planting time, and the vigour of the progeny at the age of one year. In order to throw some light on this question data showing the vigour of the parents, the vigour of the runners at planting time, and the vigour of the progeny at cropping time have been set out in Table II. In addition the effect of the limitation of the number of runners is also examined.

Table II.

Table Showing Correlation Between Vigour of Parent, Vigour of Runner and Vigour of Progeny When One Year Old.

Parents.		Progeny.		
		As Runners.		As 1 Year old Plants.
		%	Actual Numbers.	%
Strong limited	Strong	23	26	38
	Medium	57	64	49
	Weak	20	22	14
Strong unlimited	Strong	3.3	3	23
	Medium	25.3	23	57
	Weak	71.4	65	20
Medium limited	Strong	7	7	20
	Medium	38.4	38	50
	Weak	54.6	54	21
Medium unlimited	Strong	0	0	6
	Medium	7.1	6	48
	Weak	92.9	78	46
Weak limited	Strong	0	0	11
	Medium	21	8	39
	Weak	79	31	50
Weak unlimited	Strong	0	0	0
	Medium	0	0	4
	Weak	100	21	96

From examination of these figures it will be seen that the group which gives more strong runners, gives more strong progeny at the age of one year. Thus strong parents give more strong and medium runners than do medium parents, and medium parents than weak ones. In the same way strong parents give more strong progeny of age one year than do medium ones, and medium ones than do weak ones. In considering cases where unlimited runners were taken, the same phenomenon is observable. It is interesting also to note the effect of the limitation of the number of runners. It will be seen that the result has been to render the progeny (limited) of medium parents comparable with that of strong parents (unlimited) and that of weak parents (limited) with that of medium parents (unlimited). In fact data in both tables show the very marked effect upon the vigour of the progeny of the limitation of runners. This result has also been confirmed in another experiment described in the Long Ashton Annual Report for 1925.*

II. *Difference in Proportion of Blossom to Foliage.*

It has been stated above that some parents were selected in raising these clones, which exhibited differences in the proportion of blossom to foliage. Examination of the progeny at blossoming time revealed no correlation between the proportion of blossom to foliage in parent plants with that in the progeny.

III. *" Blindness."*

In any bed of maiden strawberry plants a certain number generally have no flowers. Some of the plants are weak and possibly bear no flowers on this account, while others are more vigorous, and no such reason can be adduced for the absence of blossom. In the latter case the condition may properly be covered by the term " blind ness." For the sake of convenience the term " blindness " will be used here to cover all cases where the plant has produced no flowers, with the exception mentioned below. When propagating from " maiden " plants there is some doubt as to the advisability of taking runners from " blind " parents since there is the possibility that this " blindness " might be inherited. In addition it is possible that the parent plants might be " blind " in their second year and in that case would be removed as useless plants. Healthy plants only are being considered here, not plants which are blind, because they are " Red Plants." Blindness might be due to (1) weakness, (2) some genetical factor, (3) conditions at the time of blossom bud differentiation. In 1925, 214 runners were taken from 50 blind parents, some of which were vigorous plants, but the majority being

* A Note on Strawberry " Strains," by E. Ball, Long Ashton Research Station. Annual Report for 1925.

weak. None of them were " Red Plants." On examining these progeny at the age of one year only 12 of them were found to be blind, and all of these 12 were weak plants. The parents, at this time nearly two years old, all had flowers and bore a crop of fruit. Hence it would seem that as far as this evidence goes there is no reason against taking runners from blind maiden plants unless they were very weak or are " red plants," in which case the progeny are likely themselves to be weak or diseased. The " blindness " is in this case probably due to the conditions at the time of blossom bud differentiation. " Wild " or " rogue " plants are sometimes blind, the condition being due to the same causes as those mentioned for cultivated varieties. In some fields of strawberries very vigorous bushy plants may be seen in places and sometimes they bear no flowers. These plants have been seen in fields of Sir Joseph Paxton, Stirling Castle and Laxton, and differ from these varieties in several distinct characters. The opinion is sometimes expressed that these plants are caused by a " reversion " of the cultivated variety. They are extremely vigorous, have deep green, shiny, upcurved leaves with long stalks. When flowers are produced they are large and conspicuous with long flower stalks and inflorescence stalks. The sepals and petals are large, the latter being of a thin texture (see fig. 1.). The plants which may be termed " rogues " throw an immense number of runners, each stolon being of some considerable length. On account of this if any of these " rogues " are present in a field of strawberries, they begin to displace the culivated varieties. Some of these plants throw more than 50 runners and the length of some of the stolons may be several feet. They are useless commercially since the fruit is small, and flavourless. The remedy is of course to eradicate them from the runner bed when propagating.

To sum up " blindness " may be due to (1) disease—viz. : " Red Plant," (2) the conditions at time of flower differentiation, (3) the presence of some very vigorous " rogue " plants.

The Significance of Selection.

It has been seen above that a correlation was found between the vigour of a parent strawberry plant and its progeny, the runners obtained from a vigorous plant being more vigorous than those obtained from a weaker one. On the other hand no correlation was found between what might be termed the habit of the parent plant and that of its progeny. Some plants produce much more blossom in proportion to the foliage than do others, and this would seem to be a result due to difference in environment rather than anything inherent in the plant. It should not, however, be inferred from this that selection is of little value—the correlation found between the vigour of the parent plant, and that of its progeny, suggests its

Plate I.

FIGURE 1.

FIGURE 2.

importance. The number of weak and diseased plants in many commercial stocks is often large, and here selection would be of great value in improving the strains by gradually increasing the proportion of vigorous and healthy plants. In some cases commercial stocks are so bad, the plants being mainly weak and diseased, that time would be saved by obtaining a fresh stock of more vigorous plants and commencing selection on this. It must be borne in mind, however, that selection is not capable of improving the yield in all cases, other factors must be considered, viz. : the soil and cultural conditions. The best strain may fail under adverse conditions of soil or cultivation. In conclusion it may be said that the selection of parent plants and runners is one of the most important means of increasing or maintaining the yield of fruit.

Summary.

A correlation was found between the vigour of the parent and that of its progeny. This is not necessarily due to difference in genetical composition.

Restriction of the number of runners formed increased the vigour of the progeny.

No correlation was found between "blindness" in parents and runners, or between the proportion of blossom to foliage in the parent and that in the progeny.

The importance of the selection for propagation of vigorous healthy parent plants, true to name, is pointed out.

Description of Plate I.

Fig. 1. A "rogue" commonly found in strawberry fields. Observe the long upcurved leaflets, the long inflorescence stalk, the thin papery petals and the large calyx.

Fig. 2. Inflorescence and foliage of the variety "Stirling Castle" Compare with Fig. 1.

FACTORS GOVERNING FRUIT-BUD FORMATION—VII.

By A. H. Lees.

Influence of Summer Rainfall and Previous Crop on Fruiting of Apples.*

Introduction.

The factors that favour fruit production have long been a matter of speculation among fruit growers and others and in their widest sense may be said to be fruit growing itself. Of this large subject, however, the writer desires to review certain aspects only to which perhaps but scant attention has been paid so far. It is, of course, a fact familiar to those interested in fruit growing that a large crop in one year tends to be followed by a small crop the next year, though it is also obvious that exceptions occur at fairly frequent intervals when two large crops are produced in two consecutive years. A fact also familiar, but perhaps less so, is that a dry summer tends to give a better crop in the following year than does a wet one. To this too there are exceptions, unaccountable if taken alone, but understandable, as the writer has endeavoured to show in this paper, if taken in conjunction with the previous crop. Pathological factors are of course frequently of the utmost importance but for the purpose of this paper with the exception of aphis their influence is neglected and the tree considered healthy. Though many of the facts stated below will possibly be found to have a bearing on many, if not all, fruits it is proposed to confine this discussion to the apple.

Before considering the experimental data on the influence of summer rainfall and previous cropping on subsequent crops, it is desirable to examine some of the conceptions of the conditions necessary for fruit production. For this purpose the subject has been treated under the following headings: (1) The normal phase of growth, (2) Current conceptions of the factors necessary for cropping in apples including (*a*) Flower Production, (*b*) Spring Weather, and (*c*) Previous Crop.

* Reprinted from "Journal of Pomology and Horticultural Science," Vol. V., No. 3, July, 1926, with the kind permission of the Editors.

The Normal Growth Phase of the Apple (1).

The early activities of those parts of a young apple plant which are above the ground are mainly confined to the production of wood shoots. As the years go by, however, the plant has an ever increasing tendency to form spurs which may or may not bear flower buds. As it reaches what is, for it maturity, the production of spurs becomes abundant and the production of wood shoots of small importance.

If a single shoot of last year's growth be examined in the spring it will be noticed that the buds are developing at an uneven rate. Roughly speaking the terminal bud shows the most active growth and the basal the least. So weak indeed are the basal buds that frequently they remain completely dormant. At a somewhat later stage, say in late May, it will be found that though the apical three or four buds are still actively growing and producing long shoots the other buds have stopped. They have, in fact, produced various types of spurs. Roughly speaking therefore two kinds of growth can be seen, shoot growth and spur growth. With comparatively few exceptions flowers in the apple are only produced on these spurs. The spurs borne on a given year's growth vary however in strength. Just as the basal buds were originally weaker so the spurs developing from them are weaker. So weak are they (as shown by their sessile position and few leaves surrounding the bud) that it may be years before they attain sufficient strength to flower. Those nearer the apex are stronger and may flower next year while the nearest may be so strong that their axis is three or four inches long and their terminal a wood bud and not a flower bud. There is, therefore, a distinct gradient in strength ; the weakest are too weak to form flower, the medium are just in the right condition, while the strong do not cease growth in length soon enough in the season to store sufficient food for flower production.

The state of the tree as a whole has a big influence on the general reaction of these spur units. If the tree is young and vigorous or is stimulated by hard pruning or liberal manuring it tends to produce a large number of the extra vigorous spurs which, indeed, in these cases do not cease growth early in the season, but become definite wood growths. Under the reverse conditions however true spur formation is increased markedly and the tree takes on the mature, or semi-mature condition. It then becomes a mass of spur growths borne on the frame work of the tree. Some of these spurs may have flower buds and others leaf buds. It is no longer a question of forcing conditions producing wood growth and checking conditions spur growth ; spurs are produced in either case.

When the flower bud on a spur opens, its axis elongates and bears

at its tip the flower organs. Soon that portion of the end of the axis bearing the flowers thickens and forms the so-called " bourse " or knob. On this knob are borne laterally, on opposite sides but at different levels, two growing points. These are of the utmost importance to the future cropping of the tree since they form the possible supply of future flower buds. They may take one of three different directions in their subsequent development. They may remain small leaf buds or they may form flower buds with a shorter or longer axis or they may grow out into shoots. Which of these courses they take depends on the same conditions that regulate shoot and spur production in the adolescent tree. The continuous production of flowers from bourse buds year after year is of course the first essential for continuous, as distinct from biennial fruiting.

Current Conceptions of the Factors Necessary for Cropping in Apples (2).

(*a*) *Flower Production.*

Perhaps the most commonly looked for sign of a future crop is an abundant flower production. " Well ripened " wood is considered favourable for flower production. It is difficult to get a definition of this phrase from the grower, but the essential point appears to be that the wood should cease growing in length at a fairly early date. For apples this would be about the end of July. The wood also should have pronounced secondary thickening and should be of a plump appearance. When these conditions are obtained the spurs on the older wood are also well formed. That flower production is an essential is of course obvious, especially since pomologists have shown that frequently, but one in seven or one in ten flowers will set.

Most fruit growers, however, are well aware that the weight of crop is by no means proportional to the number of flowers produced in the spring. It becomes necessary to distinguish between a strong bloom and a weak bloom though, here again, it is difficult to obtain a definition. Usually, however, a good bloom has larger petals and flowers and comes out earlier than a weak bloom. This point of relatively early opening of the strong flower does not appear to have been pointed out. Usually it is considered that the late opening flower is more likely to set than the early opening flower, since it would escape inclement weather. It is, however, easy to convince oneself by simple observation that this is not so. The first flowers to come out in spring are those spur flowers situated in a " strong " position, namely near the pruning cut of two years ago. These are the spurs which produce large flowers and which have the greatest tendency to set, often several to the truss. Those in a " weaker "

position, namely nearer the base of the year's growth, are later and smaller and often fail to set. It is an abundance of such " weak " flowers that give the extraordinary show of bloom seen in some springs, a bloom, however, which usually fails to materialise in a heavy crop.

(*b*) *Spring Weather.*

The second important factor that the grower usually looks for is the character of spring weather. Frosts are feared by all, but some have gone a step further and recognise the danger of continued cold winds. It is the contention of the writer that the danger of spring frosts has been greatly overrated except in certain situations which, from the aspect of the land, form a natural drainage for cold air. A striking example of a severe frost followed by a heavy crop at Evesham is cited below.

The danger of cold winds is probably a more real one, but since such winds in spring are usually of the dry north-easterly type it is possible that a long, continued period of dryness is as important in this respect as low temperature.

(*c*) *Previous Crop.*

It is a commonplace among fruit growers that a glut crop is followed by a very scanty one. The unfortunate grower frequently finds himself as a result between the scylla of large crops and low prices and the charybdis of negligible crops and high prices. This state of affairs seems to be accepted as a sort of providential arrangement which cannot be altered. The trees are said to require a rest and cannot be expected, apparently, to bear continuous crops. That this state of affairs is not necessarily a law of nature can be seen from such fruit plants as the logan, which normally crops every year without fail. Even apples may be made to crop as many as five years continuously provided they are of a naturally good bearing habit, as in the case of Worcester Pearmain and Allington Pippin. To obtain this result, however, it is necessary to take special measures with regard to pruning and manuring, which subjects do not enter into the scope of this paper.

The Internal Condition of the Tree.

It is the writer's contention that much more attention should be given to certain factors apparently necessary for fruit production in apples. Too much weight has been been put on some factors, such as the character of the spring weather and too little on others, such as the internal condition of the tree. This factor seems indeed to outweigh all the rest in importance, so that given the proper internal

condition, spring frosts, unless very severe or long continued, can be endured with impunity. A remarkable example of this occured in the plum crop in Evesham about fifteen years ago. When in full bloom a snowstorm occured which covered the flowers completely. Later in the day this partially melted and towards night froze again. All night the blooms were locked in ice and dire prophecies were made of failure. Actually however a heavy crop was set, because the internal condition of the trees was correct.

A correct internal condition expresses itself firstly in the formation of flowers and secondly in the strength of such flowers. As pointed out earlier in this paper the mere production of flowers is no criterion of a crop ; they must be strong vigorous flowers which, although they open relatively early, have the right internal conditions for cropping. Such flowers can be only formed if the general organic reserves are found in the right place, namely, near the spurs. There appear to be two distinct factors at work here, the amount of reserves and the placing of them. For the production of reserves raw material in the form of manure must, of course, be abundantly supplied to the leaves for further manufacture. When once this organic food is formed it may be used in various ways.

(1) It may feed the crop of apples.
(2) It may feed the extending shoot system.
(3) It may feed the extending root system.
(4) It may be laid down as general reserves, especially near the spurs.

Which direction is actually taken appears to depend on two important factors, the " crop factor," and the " water factor." By the " crop factor " is simply meant whether the tree is bearing a large, moderate or small crop, or none at all. It is quite clear that, in ordinary conditions of fruit growing, when a crop is set it has a considerable pull on organic foods available through the plant's activities. So much is this so that it is recognised that the presence of a large crop causes much less extension wood to be formed than when no crop is borne, other things being equal.

The " water factor " is a more complicated one. The following conditions, however, tend to increase it ; hard pruning, abundant manuring, strong root stocks and moisture in the soil and in the air. In short everything favouring root action, especially root action in relation to the above-ground portion of the plant, causes a high " water factor."

The result of high " water factor " however produced, is to cause strong extension growth whereby organic food is used up in the process of forming new wood. According to Kraus and Kraybill (2) such a tree has a low carbohydrate-nitrogen ratio and this state is

associated with infertility. The work on this aspect has been recently surveyed by Hooker (4). The most reasonable explanation is that but little organic food is left over as a reserve near the spurs during the late summer and possibly through the winter.

Should there be no crop or a light crop and the " water factor " be low (as when dwarfing stocks are used, the manuring is not excessive and the pruning is light), and more especially when the summer rainfall is low, then the organic food reserves must go either to the spurs and adjacent storage tissue or to the roots. They cannot go to make extensive growth or to feed the crop.

In mature or semi-mature apple trees pruning is no longer an important factor and the stock is constant so that, eliminating the effect of manuring which is outside the scope of this paper, the chief factors out of those considered above which determine the crop for the following year are :—

(1) Presence and amount of crop in the current year.

(2) Rainfall during the summer.

Experimental Data.

In order to examine the relation of these two factors with the crop production for the following year data for summer rainfall and cropping has been obtained for as many years as possible at two distinct centres, namely Long Ashton and Woburn. The important months for rainfall have been considered to be June, July and August. The reason for selection of these months is that during June from figures obtained at Long Ashton in 1919 the growth rate of apples appears to be at its maximum, and the soil humidity during July and August appear to exercise a controlling influence on the date when growth in length ceases. It is not until this event occurs that organic food can be placed in large quantities as reserve for formation of flower and fruit for the following year.

Long Ashton Rainfall.

These figures go back to 1853 and extend to 1925. From 1853 to 1872 they are obtained from the official figures for South Parade, Clifton, from 1873 to 1907 from similar figures for Pembroke Road, Clifton, and from 1908-1925 from figures recorded at the Long Ashton Research Station. The overlapping years in the record for the first two stations namely 1873 to 1891 show that the difference between these stations for these years is but a negligible one and therefore the period 1853-1907 is fairly covered by a combination of the two data. A similar argument applies to the union of the Long Ashton with the Pembroke Road figures from 1908-1925.

Long Ashton Cropping.

It has been impossible to obtain satisfactory figures for actual cropping for Long Ashton itself. Such figures could be only reliable if obtained from a mature orchard of sufficient size. The official description of the crops for Devonshire, Somerset and Cornwall, however, serve perhaps a more useful purpose, since the effect of manuring, stocks and other interfering conditions are thus automatically cut out.

Woburn Rainfall.

The figures for the June, July and August rainfall here extend from 1895-1919 and were all obtained at the Woburn Experimental Station.

Woburn Cropping.

The figures extend from 1899, when cropping was definitely beginning, to 1920, when the station was closed. The figures are the sum total of separate ones obtained from the following plots :— Bramley Dwarf Plots 1-11 and 22-41. Bramley Standards Plots, 189-200. Stirling Castle Plots, 181-188. Also from Farmers' A and B Plots, Growers' A and B, and Cottagers' A and B Plots. All plots were included except those, where, owing to drastic experimental treatment, the figures would probably be misleading.

Meteorological Observations.

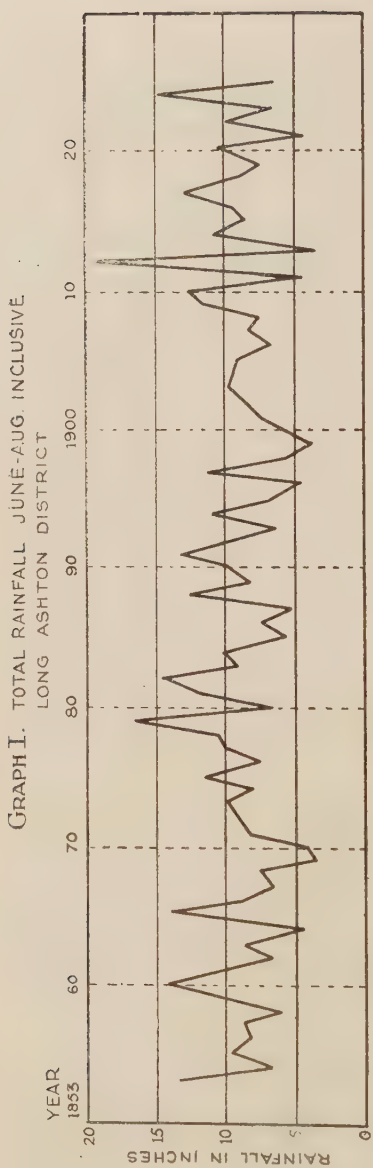
The rainfall figures in Table I. referring to the sum of the monthly totals for June, July and August, extend over a period of seventy-three years. The corresponding graph (I.) shows a series of peaks and valleys fairly regularly distributed. Taken as a whole a peak is usually quickly followed by a valley, though not necessarily in the following year. Often the graph takes two years to reach a lowest or highest point, but nevertheless there is a strong tendency for a wet to be followed by a dry year and a dry, by a wet year. This tendency suggests one reason why a young apple may be switched into the biennial bearing habit. If a dry year comes there is a considerable reduction in the " water factor " which, as shown above, induces the flower habit. The following year a crop is borne and this, if combined with a wet June-August period increases the " water factor " and uses up reserves, thus preventing flower formation for the next year. The tendency is therefore to cause biennial bearing.

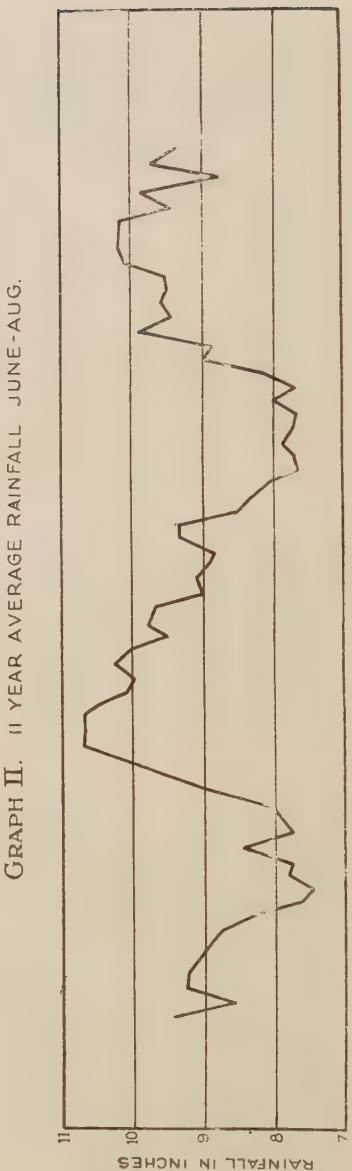
Table I.

Total Rainfall for June, July and August (inches).

Long Ashton District.						Woburn.	
1853	13.67	1878	10.21	1902	8.60	1895	7.55
1854	6.94	1879	16.82	1903	9.88	1896	5.18
1855	9.91	1880	7.89	1904	9.55	1897	6.13
1856	8.10	1881	11.97	1905	9.30	1898	6.90
1857	8.58	1882	14.79	1906	6.72	1899	3.40
1858	5.98	1883	9.32	1907	8.29	1900	7.85
1859	9.82	1884	10.16	1908	7.52	1901	5.58
1860	14.65	1885	5.30	1909	11.49	1902	7.60
1861	10.04	1886	7.73	1910	12.87	1903	12.14
1862	6.71	1887	5.32	1911	4.50	1904	5.41
1863	9.04	1888	13.02	1912	19.12	1905	7.50
1864	4.24	1889	8.23	1913	3.72	1906	5.32
1865	14.32	1890	9.98	1914	11.04	1907	5.88
1866	9.54	1891	13.34	1915	8.42	1908	4.99
1867	6.85	1892	9.61	1916	9.84	1909	9.40
1868	7.28	1893	7.31	1917	13.26	1910	5.69
1869	3.39	1894	11.02	1918	9.32	1911	3.64
1870	4.09	1895	7.76	1919	7.71	1912	10.35
1871	8.42	1896	4.45	1920	10.49	1913	2.85
1872	9.32	1897	11.42	1921	4.33	1914	5.11
1873	9.93	1898	5.49	1922	10.11	1915	7.54
1874	8.04	1899	3.66	1923	6.60	1916	6.72
1875	11.63	1900	5.84	1924	15.05	1917	11.18
1876	7.30	1901	7.42	1925	6.48	1918	5.53
1877	10.09					1919	6.65

Whereas in most parts of the graph this up-and-down tendency is seen, there are two points, from 1869-78 and 1899-1910, where the graph is fairly smooth. This point is more clearly shown in the lower graph II., representing eleven year period averages. This period of years was taken owing to the well-known eleven year sun spot period. If a similar eleven year periodicity were taking place in the summer rainfall a straight line should be produced by eleven year averages. Actually, however, a different type of curve was obtained. A period of extra dry summers occured round about 1870, and a similar one about 1900. Between 1870 and 1880, and to a less extent from 1900 to 1910, there is a continued sharp rise culminating in one case in the well-known wet period of the eighteen eighties, and in the other case to the less marked years of 1909, 10 and 12.





The graph suggests that there is a major periodicity of about thirty years. It is impossible to say whether this would really be thirty-three, namely three sun spot periods, but the closeness of the figures is suggestive. After attaining a general maximum there seems a tendency for a slow decline extending over twenty years or

so. This can be seen from 1879-97, and parts of a similar curve from 1858-67 and 1915-25, though the latter is somewhat doubtful.

On the whole therefore there appears to be a general tendency for a ten years dry period followed by a twenty year period which is wet at first but gradually becomes drier. There is some suggestion, though not a marked one, that the next five summers will, on the whole, be drier

The Relation of Summer Rainfall to the Succeeding Crop.

Long Ashton District.

It was pointed out earlier in the paper that after excluding pests, diseases and manuring the only remaining factors varying from year to year were weight of crop and summer rainfall. It is the writer's contention that when the apple crops over a large area are considered these two remaining factors determine the crop for the succeeding year. The evidence for this is shown in Tables II. and VI. the former referring to results obtained for Long Ashton district and the latter for Woburn.

In Table II. all the various factors are placed side by side. Column 2 contains the actual crops of last year (Ministry of Agriculture's description for Somerset, Devon and Cornwall). Column 3 contains the summer rainfall in inches and the indication of dry (D), medium (M), or wet (W) types. Less than six inches total is considered as dry, six to nine inches total as medium, and over nine inches total as wet. These figures are chosen not from any scientific standpoint, but simply because it is found from experience that a rainfall of under six inches total gives an impression of a markedly dry summer, and one of over nine inches of a markedly wet one. These conditions are also associated with an unusually dry and unusually wet soil respectively during the critical months, June-August. Column 4 contains the abbreviated description of apple blooming in the south of England from the reports of " Southern Grower " and " Market Grower," in the *Gardeners' Chronicle.* It has unfortunately been impossible to obtain such reports from the south-west to which the crop descriptions apply. There is therefore a possibility that, could such descriptions have been otbained, the results might have been slightly different, but they are as they stand exceedingly suggestive. Column 5 contains the actual crop experienced and Column 6 the crop estimated by the use of Table III. This table contains an empirical scheme for working out probable crops for the following year. Following the arguments cited earlier in this paper, it is based on the reaction of the two factors (1) previous crop, (2) summer rainfall. The crops are divided into, heavy, medium, light and none.

Table II.

Relation of Previous Apple Crops and Summer Rainfall to Flower Production and Crops of next year. Long Ashton District.

Year	Previous Crop.	Previous Summer Rainfall.	Flower Production.	Actual Crop.	Estimated Crop.
1906	.. ..	.. .. ..	.. ..	Fair	.. .. ..
1907	Fair	M (6.72) ..	.. ..	Very short	Medium.
1908	Very short	M (8.29) ..	Very good	Fairly plentiful	Good.
1909	Fairly plentiful	M (7.52) ..	Well covered	Blighted, but fairly plentiful. A.	Poor—medium.
1910	Blighted but fairly plentiful	W (11.49) ..	Poor	Very poor	Poor—very poor.
1911	Very poor	W (12.87) ..	Very good	About Average	Medium—good.
1912	About average	D (4.50) ..	Magnificent	Fairly plentiful	Good.
1913	Fairly plentiful	W (19.12) ..	Good	Very poor	Very poor—poor.
1914	Very poor	D (3.72) ..	Profuse	Abundant	Very good.
1915	Abundant	W (11.04) ..	Good promise	Poor. A.	Very poor.
1916	Poor	M (8.42) ..	Poor—very poor	Very short	Good.
1917	Very short	W (9.84) ..	Full of promise	Heavy	Good.
1918	Heavy	W (13.26) ..	Good and bad. Many leafy spurs	Small	Very poor.
1919	Small	W (9.32) ..	No remark given	Good	Medium—good.
1920	Good	M (7.71) ..	More than expected ..	Very small	Poor.
1921	Very small	W (10.49) ..	Tremendous	Rather above average ..	Medium—good.
1922	Rather above average ..	D (4.33) ..	Big bloom	About average	Medium—good.
1923	Average	W (10.11) ..	Good show	Under average. A. ..	Poor.
1924	Under average	M (6.60) ..	Poor show	Below average	Good—very good.
1925	Under average	W (15.05) ..	.. ..	Light	Poor—medium.

Rainfall. W—wet ; M—medium ; D—dry. Figures in brackets, June-August Rainfall in inches,

A—Excessive aphis attack in this year.

the rainfall into wet, medium and dry. A special class is made for cases where no crop at all set owing to spring frosts. When this happens the following year's crop is almost certain to be good unless a second spring frost occurs. In the other cases the probable crop depends on the reaction of the two factors. A wet summer and a heavy crop favour poor crops the next year, but a dry summer and a light crop favour a heavy crop the next year.

TABLE III.

Scheme for Apple Crop Estimation.

Crop.	Rainfall	Succeeding Crop.
Heavy	Wet	Very poor.
.. .. ..	Medium	Poor.
.. .. ..	Dry	Medium.
Medium	Wet	Poor.
.. .. ..	Medium	Medium.
.. .. ..	Dry	Good.
Light	Wet	Medium.
.. .. ..	Medium	Good.
.. .. ..	Dry	Very Good.
None	Wet	Good.
.. .. ..	Medium	Very good.
.. .. ..	Dry	Very good.

In view of the fact that for ease of working the scheme has to be made rather diagramatic the agreements between estimated and actual crop is fairly close. In certain cases 1909, 10, 11, 13, 19, 21, 24 and 25 as the factors come between two classes the corresponding estimated crop is similarly expressed.

There are certain well-marked exceptions to the estimates. These occur in the years 1907, 1916, and 1924. No explanation can be made for 1907, but the great reduction of crop over estimates occurring in 1916 and 1924 are quite obviously due to the overwhelming aphis infestation of 1915 and 23. The years should have had "good" and " good—very good " crops respectively if only subject to rainfall and previous crop factors. The effect of the aphis was therefore very damaging to the next year's crop.

Flower Production.

These descriptions, contained in Table IV. and put down shortly in Column 4 of Table II., though they come from the south instead of south-west, are very interesting when compared with the actual crop produced. It is, of course, well-known that a good bloom does not necessarily mean a good crop, and it is the writer's contention that certain combinations of the two important factors give a heavy

Table IV.

Description of Display of Apple Blossom from *Gardeners' Chronicle.*

1908	Apples very well furnished.
1909	Most varieties well covered.
1910	Some profuse, others small or none.
1911	Apples as abundantly supplied with blossom as they were poorly last year.
1912	The apple blossom was magnificent.
1913	On the whole a good display.
1914	Very striking profusion.
1915	Many varieties promising well.
1916	Poor to very poor.
1917	Nearly all varieties full of promise.
1918	Some varieties well furnished, some bare. Many spurs on opening proved to be leaf buds.
1919	No remark, apparently average.
1920	More bloom than expected after last year's great crop.
1921	The display of bloom is tremendous.
1922	Blooms even on one-year-old shoots.
1923	Good show, weather hindered development.
1924	Rather poor show.

bloom followed by poor sets and heavy June drops. According to this hypothesis these poor sets and heavy drops are not due so much to unfavourable weather conditions following or present at flowering time, but to conditions occurring the previous year. In other words, it is the internal condition of the tree that is by far the most important point. The tree does not thin itself because it knows it cannot sustain its crop, but because the June drop is predestined. As an example of conditions under which, according to the popular theory, thinning, should have taken place, but did not, may be cited the plum crop at Evesham in 1911. An enormous crop was set and despite the extreme drought stayed on the trees, though the resulting plums were of so poor a quality that many remained unpicked.

Flowering in Relation to Cropping.

An inspection of Table II. shows in some cases that the crop is in strict proportion to the flower production, but that in other cases it

falls far short. These later cases are examples of the well-known failure to set referred to above. The facts are made clearer if the cases are grouped. It is then found that extra good bloom are followed by only average crops when the previous crop is light and rainfall wet or medium. Examples of this occur in 1908, '11 and '21. A similar result is obtained by a combination of medium crops with dry summers as in 1912 and '22. Good blooms followed by poor or very poor crops occur after heavy crops with wet summers (1915), or heavy crops with medium summers (1920), or medium crops with wet summers (1913 and '23).

TABLE V.

Factors arranged in Descending Order of Cropping.

Previous Crop.	Previous Summer.	Expected Flower.	Expected Crop.
Light	Dry	Very good ..	Very good.
Light	Medium	Very good ..	Good.
Medium	Dry	Very good ..	Good.
Light	Wet	Very good ..	Medium.
Medium	Medium ..	Medium ..	Medium.
Heavy	Dry	Medium ..	Medium.
Medium	Wet	Medium ..	Poor.
Heavy	Medium ..	Medium ..	Poor.
Heavy	Wet	Poor	Very poor.

The complete results are summarised in Table V. in descending order of flowering and cropping. In most cases a fair amount of flowers is developed. Bad flowering years are accounted for either by a heavy crop accompanied by a wet summer, or by any combination where the trees have suffered a severe aphis attack the previous year.

Woburn District.

The data applying to this place are found in Table VI. Column 3 contains the total crop weights in kilos on the selected plots, Column 4 the letter indicating heavy, medium or light crop, Column 5 the rainfall figures in inches for June-August, with indicative letter for wet, medium and dry summers, and Column 6, the crop estimated according to Table III.

The table is similar to Table II., except that no flower descriptions are available and a special column has been made for the average expected crop. This is necessary since the trees were young when crop records were first taken. The trees gradually have a larger bearing surface as the years go by and consequently may be expected to bear a continually larger crop.

In order to arrive at some sort of a figure on which to base an idea of the relative size of the crop an attempt was made to get an average figure for each year. To do this an average of the first four

TABLE VI.

Relation of previous Apple Crops and Summer Rainfall to Crops of next year.

WOBURN.

Year	Expected Crop Average. Kilos.	Actual Crop. Kilos.	Relative Description		Rainfall Previous June-Aug.	Estimated Crop.
			Current Year.	Previous Year.		
1899	364	173	L			
1900	728	2,039	H	L	D (3.40)	Very good.
1901	1,092	3,176	H	H	M (7.85)	Poor.
1902	1,456	1,181	M	H	D (5.58)	Medium.
1903	1,820	0 F	O	M	M (7.60)	Medium.
1904	2,184	8,868	H	O	W (12.14)	Good.
1905	2,548	132 F	L	H	D (5.41)	Medium.
1906	2,912	5,352	H	L	M (7.50)	Good.
1907	3,276	7,403	H	H	D (5.32)	Medium.
1908	3,640	3,244	M	H	D (5.88)	Medium.
1909	4,004	13,386	H	M	D (4.99)	Good.
1910	4,368	3,299	M	H	W (9.40)	Very poor—poor.
1911	4,732	14,733	H	M	D (5.69)	Good.
1912	5,096	1,903 F	L	H	D (3.64)	Medium.
1913	5,460	11,723	H	L	W (10.35)	Medum—good.
1914	5,824	498 F	L	H	D (2.85)	Medium.
1915	6,188	12,795	H	L	D (5.11)	Very good.
1916	6,552	757	L	H	M (7.54)	Poor.
1917	6,916	20,735	H	L	M (5.72)	Good.
1918	7,280	1,362	L	H	W (11.18)	Very poor.
1919	7,644	15,876	H	L	D (5.53)	Very good.
1920	8,008	609	L	H	M (6.65)	Poor.

Rainfall.Figures in brackets—inches. D—dry ; M—medium ; W—wet years.
Crop Description. O—none ; L—light ; M—medium ; H—heavy.
F—frost in Spring.

years' crop and the last four years' were taken as the two extremes. It was further assumed that between these points the trees would gradually and evenly increase in bearing powers. This assumption is of course not strictly true, since in the early years a tree is slow in coming into bearing and in the later years quick to do so.

It is, however, the nearest approximation that can be made for purposes of comparison with the actual crop in order to decide whether the crop is relatively heavy, medium or light. Partly as a result of this error the estimations for crops do not agree so well with the actual as in the case of Long Ashton estimates. It should be further noticed that the crop weights are collected in this case from a heterogeneous collection of varieties and forms, as well as from trees under different treatment. Disagreements occur in 1901, 03, 05, 07, 10, 12, 14. These exceptions may be divided into two classes, those in which the crop is deficient, as in the years 1903, 05, 12, 14, and those in which the crops is in excess as in the years 1901, 07 and 10. All the first cases are accounted for by frost. Thus the screen minima on May 13th and 25th, 1903, were 32.4 and 30.7. Grass minima show on the average five degrees more frost, making this 7° of frost on the latter date. The year 1905 showed six frosts in May, the lowest being 24.6° screen reading. In 1912 on May 1st a temperature of 29.5° in the screen was recorded, and in 1914 six frost screen readings, the lowest being 25°, were also recorded. There is good evidence therefore to show that for these four years frost was the deciding factor. Four years in twenty-one years record is certainly an undue number and suggest that the Woburn Station was not suitably situated for growing fruit. In a similar series of years for the Long Ashton district no clear case of frost damage has been found.

The second cases, where the crop is in excess of the estimates, can be less easily accounted for. It should be remembered, however, that two factors introducing uncertainty are present, the differential treatment given experimentally and the impossibility of obtaining a true figure for the expected crop. It is known of course, that high manuring will under certain circumstances add to the food reserves available for the spurs and thus aid cropping the next year. The irregularity in 1901 may perhaps best be accounted for by the fact that the trees were only just coming into bearing. The excess in 1907 is largely due to the extra large crop borne by the Bramley dwarfs and standards, plots 1-11, 22-41, 189-200. In 1910, while most groups gave a considerably lower crop than in 1909, a few gave equal crops this making the total higher than it should be. The system if applied to the individual group works correctly, but if applied to a mass of uneven trees causes errors. At Long Ashton, where the crop amounts were obtained from large areas no such discrepancies occurred. For the other years the estimated and actual crop agrees reasonably well and thus supports the evidence obtained from the Long Ashton conditions.

Conclusion.

The evidence cited appears to show that, when stock influence, manuring and pruning are eliminated, the two factors of the previous crop and previous summer rainfall, by their interaction, are largely influential in deciding the amount of the future crop.

Also that these two factors, in trees not interfered with by pests or disease, by their interaction determine the amount of flower produced, but that the amount of flower produced is not a certain indicator of the following crop.

That when a bad aphis attack was present the crop for the following year was reduced far below the expected amount.

That the action of frost in spring caused a similar drop, but that the importance of this factor has probably been overrated.

That from a consideration of the results it should be possible firstly to forecast the probable crop over the country and secondly for the individual fruit grower to forecast his own particular crop. To do this he must allow for any manurial or pruning treatment he is himself giving. As pointed out previously in this paper, it is quite possible to throw trees into continuous cropping by regulating the manurial factor and " water factor " in the right direction. Frequently it is simply a case of right manuring both quantitively and qualitively but in many cases occur in the field where this does not avail. In these cases the grower must rely on altering the " water factor," which can be done by temporarily withholding manure and by applying the proper pruning, as well as by ringing and cover cropping. It should be clearly recognised, however, that though such treatment may move the condition of the tree in the desired direction, namely cropping, it may not keep it there.

Every year the condition of the tree must be judged and the treatment given it must be based on the results of that judgement. Fruit growing is, in fact, an art based on science.

Summary.

1. This paper sets out the evidence showing the influence of the previous summer's rainfall (June-August) and the previous crop on the current year's cropping in apples.

2. The normal phase of growth in a one-year-old apple shoot is described, and its connection with cropping of the future tree discussed.

3. Current opinions of the factors influencing cropping may be grouped under three heads, Flower Production, Spring Weather and the Previous Crop.

4. It is maintained that far greater attention should be paid to the internal condition of the tree than to external conditions at the time of setting ; that this internal condition depends on the presence and position of organic food reserves ; that their presence depends, after eliminating pests and diseases, on proper manuring, but that the amount depends on (*a*) the weight of the previous crop, and (*b*) on the date at which extension shoot growth ceases ; this latter again depends to a small extent on the amount of crop borne, but to a far larger extent on the rainfall during June, July and August.

5. When the influence of pests, diseases, manuring, pruning, and stock influence are eliminated, therefore, the remaining factors of previous crop and summer rainfall determine the future crop in the large majority of cases.

6. Data illustrating rainfall figures and cropping for Long Ashton district and for Woburn are presented together with crop estimates based on a key table.

7. The connection between the previous year's rainfall and crops on the resulting development of flower and crops for the succeeding year is shown.

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FURTHER EXPERIMENTS ON THE CONTROL OF AMERICAN GOOSEBERRY MILDEW.*

By R. M. Nattrass.

The promising results obtained from the spraying experiments carried out in the Bristol Province in 1925† made it appear desirable to continue similar trials on the same lines in 1926. In those experiments the advantage that accrued from an early application of the spray fluid, before any sign of the mildew was visible, was shown.

The most suitable time for this application is considered to be immediately after the setting of the flowers. In warm sheltered plantations there seems to be no reason why the initial spraying should not be given earlier still, as spraying does not appear to affect the setting of the flowers. The effect of this early spraying is to check the spread of mildew arising from minute infection centres set up by the winter fruiting bodies of the fungus which—lying on or near the surface of the ground and on the old mildewed twigs—are in the act of producing innumerable spores.

It was suggested from these experiments that Burgundy Mixture, owing to its well-known fungicidal properties and adhesive nature, might be an efficient preventive if applied once only at a sufficiently early stage. Since most growers are naturally averse to spraying their bushes twice it was decided to test the relative merits of one application of Burgundy Mixture against one and two applications of Ammonium Polysulphide, a fungicide of proved efficacy against American Gooseberry Mildew, and simultaneously, to ascertain the value of a second application of Ammonium Polysulphide.

An account of these trials is given below in section A.

Since a good degree of control of the Mildew was obtained in the 1925 trials by the use of the Washing Soda and Soft Soap spray fluid a further trial comparing the value of this fluid with the standard Ammonium Polysulphide wash was carried out at another centre.

These trials are described in Section B.

* Reprinted from Journ. Min. Agric., Vol. 33, No. 2, Feb., 1927.

† Journal of Min. of Agriculture, Vol. 33, June, 1925, and Report of Long Ashton Research Station—1925.

Section A.

The Plots.

The plots consisted of well grown Whinham's Industry bushes in series of double rows, each series being 25 feet apart and containing 48 bushes. Seven of these series were taken for the experiment. The control plot consisted of the eight central bushes in each series forming a strip running through the centre of the plot, thus allowing for any variation in intensity of attack which might occur in different portions of the plot.

Sprays.

The two following spray fluids were used :—

A. Ammonium Polysulphide and Soft Soap.

Ammonium Polysulphide ..	½ gall.
Soft soap	5 lbs.
Water to make up to	100 galls.

B. Burgundy Mixture.

Copper sulphate	8 lbs.
Washing Soda	20 lbs.
Water to make up to	100 galls.

Application.

In the application of these sprays, two of the series were sprayed with Burgundy Mixture, three with Ammonium Polysulphide once, and two with Ammonium Polysulphide twice.

The first application in all cases was given on April 22nd—immediately after the setting of the flowers. At this time no mildew was visible on any of the bushes.

The machine used was a hand pumped " Rapid " sprayer, worked at a pressure of 60 lbs. The bushes were given a thorough spraying, special care being taken to wet the central portion of the bushes and the under sides of the leaves thoroughly. To ensure uniformity the whole of the spraying was done personally by the writer.

No damage was observed in any of the bushes sprayed with Ammonium Polysulphide, but after about 10 days the leaves of the bushes sprayed with Burgundy showed a certain amount of spotting and this was followed later by an entirely negligible amount of leaf drop. The set and ripening of the fruit was in no way affected.

The plots receiving two applications of Ammonium Polysulphide were again sprayed on May 18th. By this time a considerable amount of new growth had been produced, and although a certain amount of mildew was present on the control bushes, none was observed on the sprayed bushes.

Results.

The fruit was picked on June 21st and was sorted into clean and mildewed berries and then weighed.

The following table gives the weight of clean and mildewed berries from each plot :—

A.

Spray fluid used.	No. of times applied	Date.	Crop. Weight in lbs.		% Weight of mildewed berries.
			clean. lbs.	mildewed. lbs.	
Ammonium Polysulphide	Once	April 22nd	456	84	15.5%
Ammonium Polysulphide	Twice	April 22nd & May 18th	502	30	5.6%
Burgundy Mixture	Once	April 22nd	482	22	4.3%
Control	—	—	143½	95½	39.9%

In considering the above figures it must be borne in mind that there was a greater number of berries in a given weight of mildewed fruit from the control plot than in a given weight of mildewed fruit from a sprayed plot, as, owing to inhibited growth, the average size of the berries was much smaller. Sorting was done by labourers in the same way as when dealing with a commercial sample. The crop was tipped on to a sloping sorting board and the mildewed berries removed from the bulk. No differentiation was made between slightly and completely mildewed berries.

It will be seen that one early spraying with Ammonium Polysulphide gave a considerable degree of control, the once sprayed plots having 15.5% of the crop mildewed as against 39.9% of the control plots. A second spraying 26 days later gave a further reduction of approximately 10% of mildewed fruit. The grower himself must decide whether this further reduction will warrant the cost of a second application of spray fluid. It must be further noted that not only does this second application give a more complete control as regards fruit, but it also very considerably checks the development of mildew on the young sappy growths of new wood which, if left to over-winter, are a potential source of danger the following season.

The plots sprayed once with Burgundy Mixture gave only 4.3% of mildewed berries by weight in this particular trial a degree of control greater than that obtained by two applications of Ammonium Polysulphide. The efficacy is doubtless due to the good spreading powers of the fluid and to the lasting character of the deposit on wood and foliage. This deposit was plainly

discernible up to the time of picking the crop, in spite of heavy rain from time to time. Such a film of deposit would have the effect of inhibiting the germination of spores for a prolonged period. Its value lies more in its power of forming a toxic preventive film than in its use as a "hitting" spray; for the latter purpose a wetting spray containing soap is to be preferred, but Burgundy Mixture must not be applied later than the setting of the flowers, for experiments in 1925 showed that not only does it fail to check the disease when once a hold is obtained by the mildew but also the deposit left on the fruit renders it quite unsaleable.

Further experiments are needed to show whether the high efficiency of the Burgundy can be maintained and at the same time its strength reduced to avoid all leaf damage. Should weather conditions be exceptionally favourable to the disease or the bushes be especially strong growing and environment render them very susceptible, a further application of a "hitting" spray fluid containing soap is to be recommended.

Section B.

The Plots.

In this case the plot consisted of six parallel rows each containing 150 bushes of Whinham's Industry—4 years old. One end of the plot was overshadowed by some tall elm trees. As would be expected, it was here that the heaviest attack of the mildew occurred. The plot was divided up into 12 smaller blocks of approximately equal sizes. These smaller blocks received the spray fluids in the following order :—

No. of Blocks.

1, 5, 9 — ammonium polysulphide and soft soap.
2, 6, 10 — proprietary soda sulphur———
3, 7, 11 — washing soda and soft soap.
4, 8, 12 — control. No spray.

Spray Fluids.

The following spray fluids were used :—

1.	Ammonium polysulphide	½ gallon
	Soft soap	6 lbs.*
	Water to make up to	100 gallons
2.	Proprietary soda sulphur compound	10pints.
	Soft soap	6lbs.*
	Water to make up to	100 gallons.
3.	Washing soda	18 lbs.
	Soft soap	10 lbs.
	Water to make up to	100 gallons.

* 5 lbs. per 100 gallons is the usual amount of soap used in these formulæ—an extra lb. was added owing to the excessive hardness of the water.

Application.

All three spray fluids were applied at the same time. The first application was given on April 22nd—a certain amount of mildew was then visible on young growth in the vicinity of the elm trees.

The second application was given on May 18th by which time a considerable amount of mildew was present on the control bushes and a small amount on the sprayed bushes under the elms.

Results.

The fruit from the plots was picked on June 21st and the crop was treated in the same way as that from the experiment described under (A). The fruit from each of the same series was mixed in order to obviate as far as possible the inequalities of the plot.

Table (B) shows the weights of clean and mildewed berries from each of the series :—

B.

Spray Fluid used.	Dates of application.	Crop. Weight in lbs.		% weight of mildewed berries.
		Clean. lbs.	Mildewed. lbs.	
Ammonium Polysulphide	April 22nd & May 18th	69	33	16.3%
Proprietary soda sulphur	ditto.	122	20	14.0%
Soda and soap	ditto.	95	41	30.1%
Control. No spray	—	66	98	53.6%

Remarks.

The degree of control obtained in this experiment was poor throughout when compared with that obtained in the experiment (A). This may be accounted for by the fact that the plot was exceptionally favourably situated for an attack by the disease. The effect of the elms was not only to " draw up " the bushes into young sappy growth but also by means of shading and sheltering from wind to favour the dissemination and germination of spores. On the series receiving no spray more than half of the crop was destroyed. The maximum degree of control was obtained by the sulphur and soap spray fluid, and it is with this that the efficacy of the soap and soda fluid should be compared. As heavy showers of rain were experienced after the last application, the value of these fluids was much impaired. This was particularly so with the soap and soda fluid, which appears to act mainly as a " hitting " spray, *i.e.*, the powdery stage of the mildew is killed on coming into contact with the fluid.

The soda and soap is undoubtedly toxic to mildew, but it must be applied as often as weather conditions render its application necessary. No hard and fast rules can be laid down.

ONION IMMUNITY TRIALS, 1926.

By R. M. Nattrass.

A further trial on the immunity of varieties of onion to the White Rot Disease *Sclerotium cepivorum* was carried out in collaboration with Mr. E. Holmes-Smith, Adviser in Agricultural Botany, the University of Manchester. Marked resistance to the disease had been found in certain varieties by Mr. Holmes-Smith in the North of England, and it was at his request that these varieties were tested on contaminated land in the South-West.

The variety usually grown in the Bristol district for the "Green Bunching Trade" is White Lisbon, a variety which is very susceptible to the White Root Rot. As this variety is grown from year to year in the same vicinity, much of the land has within recent years become badly contaminated with the fungus.

As no direct control measures against the disease are known, the information as to the relative resistance of varieties should be of interest to growers.

The seed for this trial which was supplied by Mr. Holmes-Smith was drilled in single rows and the crop lifted on August 12th.

The table below gives the number of clean and diseased bulbs of each variety :—

Variety.	No. of clean roots.	No of diseased roots.	Percentage diseased roots.
1. Magnum Bonum ..	566	191	25.2%
2. Giant Zittal ..	860	233	21.4%
3. Cranston's Excelsior	1100	270	19.7%
4. A.1	910	197	17.7%
5. White Lisbon ..	440	90	16.9%
6. Bedfordshire .. Champion ..	1300	243	15.7%
7. Cranston's Excelsior	1190	209	14.2%
8. Wroxham Globe ..	1260	134	9.6%
9. Rowsham Park Hero	1100	90	7.5%
10. Up to Date ..	1380	86	5.1%

No variety appeared to be immune, but the season was exceptionally favourable to the development of the disease.

THE WHITE ROOT ROT OF FRUIT TREES CAUSED BY ROSELLINIA NECATRIX. (Hart.) Berl.

(Progress Report.)

By R. M. Nattrass.

The White Root Rot of fruit trees caused by *Rosellinia necatrix* (Hart.) Berl., has attracted very little attention in this country and records of its occurrence are few. Doubtless the disease in the past has occasionally been confused with that due to the Honey Fungus, *Armillaria mellea*. Quel. as there is superficially some resemblance between the two parasites. *R. necatrix* has long been known on the Continent as the cause of a serious disease of the Vine and of fruit trees. The disease was first studied and described by Hartig (4) in 1883, the name *Dematophora necatrix* being given to the parasite involved, whilst an account of a more thorough investigation of it was published in 1891 by Viala (7) who, after the discovery of the perithecia, retained Hartig's name and placed the genus in the group *Tuberales*, on account of the completely closed and subterranean character of the perithecia The fungus, however, was transferred later to the genus *Rosellinia* by Berlese (2).

The perithecia seen and described by Viala and by Delacroix were obtained by keeping infected roots under artificial conditions but since in neither case did the author's mentioned succeed in getting the ascospores to germinate, valid proof of a genetic connection between the perithecia and the vegetative and conidial forms described is lacking. Perithecia have not yet been recorded from Great Britain so that some uncertainty still exists as to the exact systematic position of the fungus described in this note. There is, however, little doubt, that the vegetative and conidial stages of the fungus occurring here are identical with those of *Dematophora necatrix* described by Viala

It is interesting to note that the " Root Fungus " recently described by Cunningham (3) in New Zealand and provisionally assigned by him to *Rosellinia radiciperda*, Massee, closely resembles the European White Root Rot fungus, but no fructifications of any kind were found in connection with the New Zealand form. The unsatisfactory state of our present knowledge concerning this matter is well summarised by the author mentioned.

According to Massee (5), and to Wilson (8), the disease is rare in this country and no record of its occurrence is to be found in the Ministry of Agriculture's Plant Disease Survey Reports covering the years from 1917 to 1924, the last published. The fungus was however definitely recorded from Norwich (1) in 1900, and from Canterbury by Salmon (6) in 1913. No record has been found of the occurrence of this fungus in the Midlands or the North of England although another species, probably *R. aquila*, was reported by Wilson (8) in 1912 as the cause of a disease of Spruce seedlings in Scotland.

Rosellinia necatrix first came to the notice of the writer in the summer of 1924 when certain Bramley's Seedling apple trees in full bearing were reported to be dying off in an orchard near Taunton, Somerset. The fungus was isolated from the roots of these trees. In 1925 it was observed to be the cause of the death of apple trees in a garden at Winscombe, Somerset, and in the same year a piece of infected apple root from the Isle of Wight was received from Dr. G. H. Pethybridge from which cultures of *R. necatrix* were obtained. In 1926 a third case of attack was seen also at Winscombe, and later in the summer it was found attacking potato tubers and roots in the same garden. Narcissus bulbs and also potatoes attacked by this fungus have recently been found by Dr. G. H. Pethybridge, on material received from Mr. Gibson from the Isles of Scilly, whilst corms of Arum and roots of Elm are also reported as being similarly attacked there.

It seems probable then, that *Rosellinia necatrix* may be fairly widely distributed in the warmer parts of the British Isles but perhaps frequently passes unrecognised on account of the absence of fructifications and the comparatively early disappearance of the external mycelium. It is known to have a wide range of host plants among cultivated crops so that lack of a suitable host plant is not likely to account for the comparative rarity of records.

Symptoms of Attack.

In mature fruit trees two or three seasons may elapse before death of the tree is brought about. The earliest signs of attack are seen in the premature yellowing and fall of the leaves, this symptom being usually associated with a heavy blossom and fruit set. In the succeeding year fewer leaves are produced and much of the fruit fails to reach maturity, whilst " dying back " of the branches may be seen. Death of the tree may ensue in the second or third year of attack. The early symptoms are occasionally seen on one side of a tree only, and usually on the side adjacent to a tree that has already succumbed to the disease.

An examination of the roots of a dead tree shows that most of the fibrous root system has disappeared. The older main roots are covered with a greenish-grey web of mycelium which develops short rhizomorph-like structures taking the form of whitish strands or ribbons. The whole web is more or less flocculent and bears no real resemblance to the rhizomorphs of *Armillaria mellea*, although the symptoms above described are similar to those seen in cases of attack by the latter fungus. After the tree has been dead for some time the enveloping web disappears, leaving the surface of the roots with a characteristic dull appearance and dotted over with numbers of small, rounded, black bodies of a sclerotial nature.

The appearance of the young roots in the early stages of attack is very characteristic. Immediately on exposure the ends of the fine roots are seen to be invested with a pure white flocculent mycelium composed of very fine almost colourless hyphae. (Plate I. fig. 2). While that portion of the roots which is invested with mycelium is soft and rotting away, the portion above is still quite healthy.

When an infected tree is removed the soil in the vicinity of the roots is seen to be permeated by the spawn of the fungus in the form of small, cottony masses and of very fine, diffuse mycelium spreading in all directions.

Inoculation Experiments.

The fungus was readily isolated and grown in pure culture in various artificial media in some cases producing abundant conidiophores after 12-14 weeks.

The following inoculation experiments were carried out :—

(*a*) *Apple Trees.*

In November, 1925, one 4 year old Cox's Orange Pippin growing in a pot was inoculated by placing a piece of sclerotial tissue from a plum wood culture into a cut on the main root. At the same time one Bramley's Seedling apple tree, of the same age, was removed from its pot, a portion of a plum wood culture was placed in the bottom of the pot and the tree replaced. In neither case did infection occur.

In March, 1926, 30 Warner's King apple trees, 6 years old, growing in pots, were used for inoculation. They were uprooted and a small piece of a vigorously growing malt agar culture of the fungus was placed in a cut 2in.—3in. below the region of the collar. The cuts were then bound up with raffia and the trees replanted. The inoculations failed to take in every case.

PLATE I.

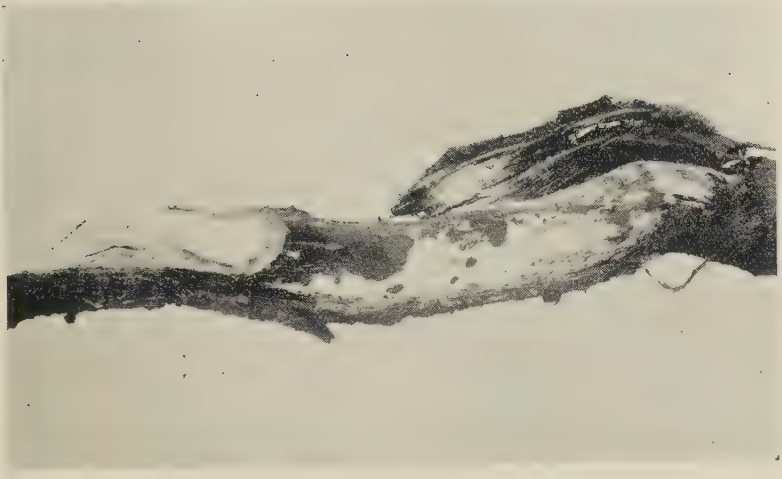

FIG. 1

FIG. 2

PLATE II.

FIG 1

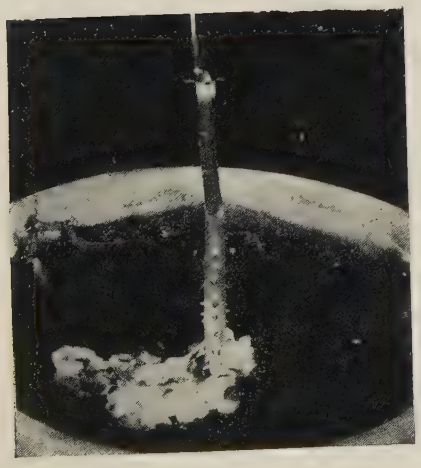

FIG. 2

FIG. 3

(*b*) *French Beans.*

In July, 1926, French beans were sown in three pots of soil which was permeated by the fine mycelial threads of the fungus taken from an infected orchard, and seed sown in two pots of clean soil served as controls. The pots were kept in a heated glasshouse. Growth proceeded normally in both the control and the infected soil pots until the plants were about six inches high. The growth of those in the infected soil then became arrested, the leaves gradually turned yellow and dropped off. An attempt was made on the part of the affected plants to produce new roots at soil level, thus giving rise to an effect similar to that which occurs with tomatoes affected with the Verticillium disease or with "Foot Rot." As the tips of these roots in turn became infected the plants attempted to produce further new roots, for a distance of two inches above soil level. Finally the fungus grew over the surface of the soil at the base of the stem in the form of a pure white mycelium. This eventually developed into an olive-green, felted disc with a pure white margin. (Plate II., figs. 1, 2 and 3). Meanwhile growth of the control plants proceeded normally.

An examination of the root system of one of the infected beans showed that it had been almost completely destroyed, a gradual rotting away from the tip backwards having occurred. Microscopical examination of sections of the main root and the remaining portion of an affected lateral root showed a compact mass of hyphae in close contact with the outermost layer of cells, but little actual penetration into the deeper tissues could be seen.

A further lot of beans was sown under similar conditions in soil similarly permeated by mycelium towards the end of October. In this case none of the plants was attacked, and all trace of mycelium in the soil disappeared. The reason for this is probably the lower temperature which then prevailed in the house.

(*c*) *Apple Seedlings.*

From the above experiments it appears that only the diffuse mycelium permeating the soil is able directly to infect the root system of the host plant. To obtain an abundance of such mycelium from a pure culture the fungus was grown on sterile sand moistened with dilute malt-extract. Three year old apple seedlings were removed from the plantation and replanted in pots, a small quantity of the sand culture of R. necatrix being placed in contact with the roots. Infection readily took place, the entire root system becoming completely invested with mycelium in from 3-4 weeks.

Life History of the Fungus.

As already described, on lifting an infected tree the soil for an

area of several feet in the immediate vicinity is permeated by the mycelium of the fungus. Two types of mycelium occur under these conditions :—

1. Greenish grey to white rather dense rhizomorph-like and fan-shaped structures.
2. A very diffuse white mycelium composed of very fine attenuated hyphae.

The rhizomorph-like mycelium probably marks the site of small roots that the fungus has destroyed or is formed by a concentration of hyphae on some organic material in the soil. The fine attenuated hyphae might be described as " exploration hyphae " which travel through the soil in search of a fresh victim. This type of mycelium fills up the minute cavities in the soil and is seen to be particularly abundant in worm burrows.

A small piece of a malt agar culture placed on damp soil in a Petri dish and incubated, quickly produces a fine web of attenuated hyphae which covers the surface. When mycelium comes into contact with the fine roots of a suitable host plant they become clothed with a mass of fine white mycelium which brings about the slow rotting away of the tissues. This is clearly seen when the roots of a recently attacked tree are exposed (Plate I., fig. 2). The only visible connection between a tree so attacked and an adjacent tree in an advanced stage of attack is this fine mycelium filling up the interstices in the soil. In the case of the beans grown in infected soil this was the only type of mycelium present.

That the effect is localised is shown by the fact that young attacked trees have been saved by trimming off the affected extremities of the young roots and replanting them in clean soil. It is doubtful if the fungus can directly attack any part of the plant other than the fine roots. In this respect it differs markedly from *Armillaria mellea*, the mycelium of which, by means of rhizomorphs, appears to be able to attack the root system of a tree at any point. Further, *Rosellinia necatrix* does not progress so rapidly under the bark and bring about death of the tree by girdling in the region of the collar as does *A. mellea*. Death of the host is brought about in the first place by the destruction of the fibrous root system.

As already stated no fructifications of the fungus have been seen under natural conditions, and it is doubtful if the conidia play any part in the dissemination of the disease. During nine years Viala only saw conidiophores in nature on six occasions ; he says that " the occurrence of the conidiophores in nature may be regarded as accidental." In Viala's experience both ascospores and pycnospores failed to germinate.

There is no doubt that the sclerotia represent the resting form of the fungus in this country and that under suitable conditions they can give rise to mycelium that is capable of travelling through the soil and attacking a healthy host plant.

Control Measures.

Control measures must consist largely of the prevention of spread of the fungus in the soil and the removal of as much as possible of the source of infection. As soon as a tree exhibits the symptoms of attack already described the roots should be exposed to ascertain if *Rosellinia necatrix* is present. If this is the case the tree should be removed and as much as possible of the root system destroyed, as it is on such roots that the sclerotia or resting stage of the fungus occurs. It must be borne in mind that apparently healthy trees in immediate proximity to a diseased one may already be to some extent attacked by the fungus. The roots of these should also be examined on the side nearest the site of the removed tree. Contrary to general belief *young trees* can, in the early stage of attack be saved by uprooting in autumn or winter, trimming off the diseased roots and replanting in clean soil.

True rhizomorphs have not been seen by the writer on diseased roots or in the soil. As the flocculent mycelium appears to be unable to withstand frequent exposure and drying out, bare fallowing the land with frequent cultivations for a season would probably have more effect than direct treatment with chemicals in ridding the land of the fungus. Carbon disulphide is said to have given good results against the White Root Rot of the Vine on the Continent.

Of prime importance is early recognition of the disease, and fruit growers who suspect its presence should not hesitate to obtain the opinion of an expert.

In conclusion the writer wishes to express his thanks to Dr. G. H. Pethybridge for many of the references and for the loan of Viala's Monograph on the Dematophora Disease of the Vine.

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EXPLANATION OF PLATES.

PLATE I.

(1) Old root of Bramley's Seedling apple tree killed by Rosellinia necatrix showing the mycelial sheet below the bark. The dark portion was exposed before the white and has turned a dark greenish black colour. Sclerotial bodies can be seen on the surface of the bark.

(2) Young fibrous roots of an apple tree—showing effect of an early attack by Rosellinia necatrix. The portion of the root above the mycelium is quite healthy. These roots are from a tree adjacent to that from which the the root in fig. (1) was taken.

PLATE II.

(1) Right and left—beans grown in soil permeated by mycelium of R. necatrix. Centre—plant grown in clean soil.

(2) Infected bean showing formation of new roots and fungus growing up into the surface of the soil.

(3) Same plant as (2) 10 days later. The mycelium has now formed a felted disc on the surface of the soil. The centre of the mycelial disc is a dark olive green.

Plate I.

FIGURE 1.

FIGURE 2.

SOME OBSERVATIONS ON "RED PLANT" OF STRAWBERRIES.

By E. Ball.

The symptoms of the malady affecting strawberry plants, known as "Red Plant" or "Red Leg," have been described in The Journal of Pomology and Horticultural Science by Ballard and Peren.* These writers indicated that further work was needed on the nature and control of the disease. In the past season the present writer has made some further observations. Briefly, the subjects under investigation were (1) the symptoms by which the disease could be recognised at times of the year other than the spring, (2) the propagation of the disease, (3) the distribution of "red plant" and (4) the possible means of control. Although the symptoms by which the complaint can be recognised in the spring have already been described as stated above, it will probably be of value to summarise them briefly here.

Symptoms.

1. *Recognition in the Spring.*

At the outset it should be stated that when a plant is affected, all the crowns are not always "red" crowns; in many cases often only one crown is affected and the remainder are apparently healthy. All stages may be met with from plants of which every crown shows the typical symptoms, down to cases in which only one crown is affected. Plants of all ages show the symptoms from the maiden plant upwards. Briefly, a "red plant" may be recognised by the following characters (1) Partial or complete "blindness." Usually the inflorescence is completely absent and when present is much reduced (see Plate I., figs. 1 and 2), the inflorescence stalk being abnormally short and the number of flowers in the inflorescence smaller than is usually the case. In addition some of the flower parts (viz. the stamens or pistils) may be abortive. This is one of the most valuable symptoms, since the complete or partial "blindness" of the plant draws the attention of the observer at once. (2) In addition to the abnormal inflorescence or its complete absence (externally), foliage characters are of value. In affected plants some

* Journ. of Pomol. and Hort. Sci. Vol. III., p.142.

of the leaves are much reduced in size. The petiole is shortened, thick at the base and tapers towards the lamina, and is almost hairless. The lamina itself is much reduced and distorted and never unfolds in the normal way (see Plate I, figs. 1 and 2) but remains puckered or crumpled. The whole leaf much resembles a young rhubarb stalk. In certain varieties, *e.g.*, " Royal Sovereign " the whole of the petiole and lamina is suffused with a purplish red colouration. The term " red plant " is an unfortunate one, since the red colouration is not a characteristic symptom for all varieties, in fact the majority of strawberry varieties do not exhibit it. Examples are " Stirling Castle " and " Sir Joseph Paxton." In such cases as these, all the other symptoms are present, but the red pigment is not developed, the latter only occurring in varieties which naturally possess a considerable amount of red pigment in the petiole.

2. *Recognition later in the Year.*

There seemed to be some doubt as to the possibility of recognising a " red plant " later in the year than the spring or early summer. In order to clear up this point a number of plants were marked in the spring and kept under observation during the following six months. It was found that each plant showed one or more of the four following characteristics :—

(*a*) The characteristic symptoms, viz. : small deformed leaves with petiole thick at the base and tapering towards the apex, could be recognised. Varieties, however, which developed red pigment highly on these leaves in the spring did not do so later in the year.

(*b*) An affected crown sometimes produced no new normal leaves.

(*c*) New crowns were generally thin and weak, and bore leaves of which long thin petioles with few hairs seemed to be characteristic.

(*d*) New healthy leaves which unfolded in the normal way were produced by the growth of daughter crowns.

The last point explains the difficulty of recognising " red plants " later in the year. It should be stated that a " red plant " is much more readily recognised in the spring than at any other time of the year. This is because in the spring the " blindness " or partial " blindness," and the development of red pigment in certain varieties are additional symptoms, but also later in the year the development of new foliage, most of which may appear to be almost normal,

obscures the true condition of the plant. Of the 49 plants marked in the spring as stated above—

23 showed the symptoms (*a*) above.
3 showed the symptoms (*b*) above.
10 showed the symptoms (*c*) above.
4 appeared to be quite healthy.
9 were very badly attacked by strawberry aphis and it was useless to look for "red plant" symptoms.

The Propagation of "Red Plant."

It is of considerable importance in practice to know whether a runner taken from a "red plant" will also itself be a "red plant." If this is so the case will have been established for drastic rogueing before attempting to propagate from a stock of plants, a high proportion of red plants considerably reducing the yield owing to the "blindness" of the plants. In connection with work on the subject of strawberry strains several strains of the variety Royal Sovereign obtained from different sources have been propagated at Long Ashton during the past two years. As a result there were available three generations of each of six strains, the first generation being three years old, the second two years old and the third one year old. In May, 1926, a count of the number of red plants in all three generations of all the strains was made.

Strains of "Royal Sovereign" Strawberry.

Number of "Red Plants" Per 1,000. (Counts Made May, 1926).

Strain.	1st Generation.		2nd Generation.		3rd Generation.	
1	202	(3)	90	(3)	50	(2)
2	64	(6)	20	(6)	10	(5)
3	218	(2)	170	(2)	50	(2)
4	70	(5)	30	(5)	7	(6)
5	136	(4)	50	(4)	23	(4)
6	304	(1)	400	(1)	140	(1)

It will be seen from the above table that the intensity with which the disease occurs in the several strains for each of the three generations is remarkably consistent. That is to say, that a strain which is most badly affected in the first generation is also the most badly affected in the second and third and so on. It should be stated that in the propagation of those strains no special attempt to eliminate "red plants" has been made. First runners only, of fair vigour were taken, but no selection of parent was made. From the above result there is at any rate circumstantial evidence that the progeny of "red plants" are likely themselves to be "red plants." That being the case there is the possibility that the disease may be controlled by rogueing as is the case with "Reversion" in black currants. In fact this seems more than probable since in the course of making observations in strawberry fields it was noted that, wherever "rogueing" or selection was being carried out, "red

plants" were absent or very few in number. In addition, cases could be found in which a certain strain was in the hands of several growers, and it was interesting to note that if a certain strain had a high percentage of "red plants" in the hands of one grower, it was in a like condition on other farms, that is, if no attempt had yet been made to carry out rogueing. On the other hand, if the strain was free, or practically free, from "red plants," it was so at all the centres at which it was seen. In fact, one of the causes of the difference between one strain and another is the degree to which they are affected with "red plant." In connection with this observational work a large number of clones were raised from "red plants" affected to varying degrees, *e.g.*, with all crowns "red" to those with only one crown affected. These plants are being kept under observation to obtain more evidence as to whether the complaint is inherited in the runner.

A large number of plants have been marked in the field to ascertain whether an affected plant remains affected or whether recovery ever takes place.

The Incidence of "Red Plant."

1. *Districts.*

Observations were made in the summer to ascertain how widespread was the disease. As a result of visits to numerous strawberry fields it was found that the disease occurs in the following Counties :—

Cambridgeshire.
Cheshire.
Cornwall.
Hampshire.
Herefordshire.
Somerset.
Surrey.
Worcestershire.

These were the only Counties visited, but they include the principal strawberry growing districts, with a few exceptions. It will be seen that the disease is widespread. Many growers are able to recognise it, especially in the Cheddar Valley and Tamar Valley districts, and some of them rogue their stocks, and in some cases have succeeded in practically eliminating "red plant."

2. *Varieties Affected.*

Several varieties have been seen to be affected, and in 1926, the following important commercial varieties were seen showing the symptoms :—

Royal Sovereign.
Madame Kooi.
Stirling Castle.
Bedford Champion.
Sir Joseph Paxton

This is not a comprehensive list and is merely given to indicate that the " Royal Sovereign," in which the red pigment symptom occurs, is not the only susceptible variety.

It is not the desire of the writer to suggest that " red plant " is the only cause of the existing deterioration of strawberry crops. It is certainly, at least, a contributory cause and is capable of leading to a serious reduction in crop.

Summary.

(1) " Red Plant " is most easily recognised in the spring at blossoming time, but can also be recognised with greater difficulty later in the year.

(2) The disease is widespread.

(3) Some strains are affected and others are free of the complaint.

(4) There is circumstantial evidence that the disease can be controlled by rogueing, the best time for this operation being at the time of blossoming.

Description of Plate.

Fig. 1. A typical " Red Plant " crown. The deformed leaves are clearly shown.

Fig. 2. A " Red Plant " crown with a reduced inflorescence, having a short inflorescence stalk. A crumpled leaf and a reduced and deformed leaf can also be seen.

OIL SPRAYS FOR SPRING AND SUMMER USE.

(PROGRESS REPORT).

By L. N. Staniland.

Oil sprays have been in use in America, Canada and elsewhere for some time but they have not so far been very popular in this country. The work on oil sprays which is being carried out at this Station aims at exploring the possibilities of using oil sprays as cheap contact washes to replace the use of nicotine. The work has, therefore, been carried out with a view to obtaining an oil spray possessing the following advantages :—

Cost.

The final cost of the spray to be not more than half of that of nicotine.

Mixing.

The oil to be such as can be mixed easily in the field by growers, emulsifying readily without heat.

The emulsifier to be some substance readily obtainable in a standard form.

In Use.

Must not damage the foliage of fruit trees.

Must have good killing power.

Experimental.

Both mineral and vegetable oils were considered as to their suitability for the purpose. Among the mineral oils tested were ordinary paraffin oil, liquid paraffin and several lubricating oils of varying heaviness. Experiments were made also with the following vegetable oils :—olive oil, sesame oil, linseed oil, cotton seed oil, rape oil and castor oil. The vegetable oils were selected primarily on account of their cost, which was in all cases sufficiently low to warrant their consideration.

The selection of likely emulsifiers was then considered. Ordinary spraying soaps of various consistencies and qualities, castor oil soap, calcium caseinate, soluble organic casein, saponin, clays and size were tested in turn in conjunction with all the above mentioned oils. In the case of the vegetable oils, caustic soda and caustic potash were tried in order to determine whether or not the oils would emulsify with their own soaps formed by action with the alkali. This, however, was not found to take place in the cold. As a result of the tests of emulsifiers with the oils, all the mineral oils were discarded as being unsuitable.

When considering field spraying conditions, it was necessary to choose an oil which would emulsify, not by shaking, but by pouring the oil into the emulsifier.

Ordinary soft soap, such as is commonly used in spraying operations, was found to be best for emulsification purposes. The form of soft soap found to be most convenient is that known as liquid soap, composed of one part of soap and two parts of water. For the emulsification of the vegetable oils, the liquid soap was diluted with water until one twelfth of it was soap—*i.e.*, a soap solution of approximately 8 per cent. strength was obtained. Equal quantities of oil and soap solution were used in two beakers. The oil was poured into the soap solution and then the whole poured back again, repeating till emulsification was complete. The following table compares the times taken for the emulsification of the various vegetable oils :—

OIL.	EMULSIFICATION.
Castor Oil	Slow. From 10-15 pourings required.
Sesame Oil	Quicker than Castor Oil. From 6-8 pourings
Cotton Seed Oil	Slightly quicker than Sesame Oil.
Linseed Oil	Quicker than Cotton Seed Oil.
Olive Oil	Quicker than any of the oils above. 1-3 pourings.
Rape Oil	Same ease of emulsification as Olive Oil.

Taking these results and the cost of the oils into consideration, linseed oil and rape oil were selected. The linseed oil was the cheaper. (Linseed oil is a drying oil, while rape oil is non-drying).

The method of mixing finally found to be most satisfactory is as follows :—

The required quantity of oil is poured into a bucket capable of holding at least double the amount, and into a similar bucket is poured an equal quantity of the 8 per cent. soap solution. The oil is poured into the soap solution and the whole poured backwards and forwards between the two buckets until emulsification is complete. In the case of rape oil, though the first pouring nearly completes the emulsification, at least four pourings should be made to ensure the completion of the process. The main bulk of water in the spraying tank should have sufficient soap added to it to give a lather. It has been found that 1 per cent. of " free " soap in the final wash gives optimum wetting power. The primary emulsion is then added to the main bulk and stirred thoroughly. With very hard waters, the addition of washing soda will partially soften the water and will be cheaper than soap alone.

Field Tests.

The linseed oil and rape oil emulsions were tested against various insects. The rape oil was found to possess rather higher killing power than the linseed oil and both were superior to the proprietary oil tested last season. The linseed oil was found to be unsuitable as it "varnished" quickly owing to the thinness of the film deposited on the plant and insect. The rape oil emulsion was found to be very satisfactory. Some idea of its killing powers may be formed from the following table.

STRENGTH OF RAPE OIL EMULSION. (1% free soap present).	INSECTS KILLED.
½%	Rose aphids, Willow aphids, Aphis pomi.
1%	Rosy Apple Aphis, half-grown larvae of *Phyllodecta vulgatissima* (Willow Beetle). Young larvae of the Willow Sawfly, young Winter Moth Caterpillars. Newly hatched larvae of Gooseberry Sawfly.
2%	Fully grown larvae of *Phyllodecta vulgatissima*. and of the Willow Sawfly. Nearly full grown larvae of Gooseberry Sawfly. Woolly Aphis.

Foliage Damage.

Rape oil emulsion has been found to be less damaging to foliage than the proprietary mineral oil spray tested last season. The variety known as "Green Dicks" of the species of willow *Salix purpurea* was found to be peculiarly susceptible to damage by oil sprays. The proprietary oil spray slightly scorched the leaves of *S. purpurea* at ½ per cent. strength, damage being severe when the strength was increased to 1 per cent. Rape oil emulsion could be used up to 2 per cent. strength without scorching. At ½ per cent. strength this fluid did not scorch the petals of roses. When used at 5 per cent. strength on apples (Beauty of Bath), just before the "pinking" stage, only very slight scorch resulted. It has been used up to 3 per cent. strength on black currant bushes, variety Seabrook's Black, in almost full leaf.

Uses of Rape Oil Sprays.

Rape oil washes would seem to have a number of advantages, among which may be mentioned the following:—

1. As delayed dormant washes at 1 per cent. strength to replace tar-distillate washes where undercrops, weather conditions or insufficient labour prevent the use of the latter.

2. As a cheap aphis wash for spring and summer use at $\frac{1}{2}$ per cent. strength.

3. As a cheap contact wash against Apple Capsid Bugs, Woolly Aphis and similar pests at a strength of from 1 to 2 per cent.

Further work on oil sprays will proceed along the lines indicated in this progress report. A series of field experiments have been planned for the coming season in which a rape oil emulsion and a lubricating oil emulsion will be tested as under :—

1. As delayed dormant sprays against aphis, apple sucker and small caterpillars immediately after hatching.

2. As spring sprays against capsid bugs.

INVESTIGATIONS ON TAR DISTILLATE SPRAY FLUIDS.

By L. E. Smith.

The rapid increase in the use of tar distillate fluids as winter washes for fruit trees since their introduction into this country in 1921 has led numerous investigators to examine the egg-killing properties of several brands which have been introduced into commerce. The reports issued on such work have shown that the commercial articles differ greatly as regards their ovidical properties and it has become evident that numerous problems relating to their use remain to be solved by the chemist and the pathologist.

The need for thorough chemical investigations on the tar-distillate fluids was recognised at this Station when the first samples of the original Dutch preparation were introduced into this country in 1921 and preliminary work carried out at that time showed that the fluid was of complex composition.

It was not possible, however, to give detailed attention to certain aspects of the chemical problems until the autumn of 1925, when special facilities were provided for the work by the aid of a grant from the Ministry of Agriculture and Fisheries.

The aims of the investigations which were then proposed were as follows :—

1. To investigate the various factors concerned in the preparation of (*a*) clear concentrated tar oil fluids ; (*b*) stable dilute tar oil emulsions.
2. To determine to what extent the toxic properties of the fluids can be correlated with various constituents.

It was not possible to complete the work under 2, during the following twelve months, owing to the lack of suitable biological material, and, as the investigations under this heading are still in progress, it is not proposed to report the results in this paper. Considerable advance was made with the chemical work and the information gained should prove of great value to those interested in the manufacture of tar-distillate fluids.

In order that the results of that section of the work may become available without delay, these have been briefly summarised for preliminary publication in this Report and are set out below.

Tar Oils Used.

During the course of the investigations several samples of tar oil—including commercial brands—were used in examining the various points which arose. The main work, however, was carried out on three types of oil of which samples were obtained specially for the purpose in view, viz. : a vertical Retort Tar Oil, B.P. 180° C.—360° C., Tar Acid content 25% ; a Horizontal Retort Tar Oil, B.P. 190° C.—360° C., Tar Acid content 12% ; Coke Oven Tar Oils, varying B.P. ranges and tar acid contents. Of these the first-named was used most widely, as it proved to be especially valuable for the work.

Summary of Results.

1. *Preparation of Tar Oil Fluids.*

Attempts were made to emulsify a sample of Horizontal Retort Tar Oil containing approximately 12% phenolic materials, with soaps prepared from the following oils :—resin, whale, soya bean, bone, coconut, linseed and castor. It was not found possible to obtain an emulsion with resin soap ; those made from all the other soaps, excepting castor oil, were unsatisfactory, whilst that prepared with castor oil though fairly stable was thick.

The experiments were repeated using a Vertical Retort Oil containing approximately 25% phenolic materials and 4.4% bases. A concentrated solution of castor oil soap dissolved in this oil immediately, giving a clear solution which diluted well with water, yielding a pink emulsion. The other soaps could be used in the same way, but castor oil soap gave the most stable emulsion.

2. *The Preparation of Concentrated Tar Distillate Fluids.*

Experiments were carried out in which the rôles of various factors concerned in the production of clear solutions of concentrated tar-distillate fluids were examined.

The acidic and basic materials were removed from a large sample of Vertical Retort Tar Oil by appropriate treatment with 10% caustic soda solution and dilute sulphuric acid and the resultant neutral tar oil was prepared for experimental purposes, a portion being dried and fractioned.

It was found that fatty acid soaps could not be dissolved in the neutral tar oils thus prepared, but when tar acid was added and the whole shaken the solutions became clear.

Using this procedure the minimum amounts of tar acid required to give clear solutions with various soaps and the neutral tar oil were

found. In these tests 2.0 grms. of soap solution, containing the equivalent of 1.0 grm. of unsaponified oil, was used and the ratio of tar oil to soap solution was 5 to 1. The tar acid generally used was o-cresol, but phenol and m. and p. cresol were occasionally employed.

It was shown that some soaps require more tar acid than others. The order of increasing amounts of tar acid required with a series of soaps was as follows :—resin soap, castor oil soap, whale oil soap, Soya bean soap, bone fat soap. This order remained the same whether a high or low boiling tar acid was used. The amount of tar acid required to give clear solutions increased with the boiling point of the acid and with the boiling point of the neutral tar oil.

Experiments were also carried out using tar bases such as quinoline and pyridine instead of tar acids and it was found that the soap neutral tar oil systems could also be cleared by the addition of these. The bases, however, were not so suitable for the purpose as the acids as larger quantities were required and the emulsions obtained on dilution were not so stable as those prepared by the use of the acids unless greater quantities of soap were used.

3. *Physical Properties of Concentrated Tar Oil Fluids.*

Concentrated tar oil fluids are usually described as emulsions, but there is little evidence of their being either oil-in-water or water-in-oil emulsions. In the anhydrous state these fluids are jelly-like and are not easily dispersed in cold water. In order that they shall be fluid a minimum of approximately 3% water must be present. This minimum depends to some extent on the nature of the oils and soaps employed. Microscopically the fluids are quite homogeneous ; they do not respond well to the " drop dilution " test for the continuous phase ; they also mix with certain oils, but in addition, dissolve small quantities of water and remained homogeneous.

The conductivities of the fluids were found to differ greatly. Some showed extremely low specific conductivities, of the order of 10^{-6} mhos., but others had conductivities of many hundred times this value. The conductivity appeared to depend on the amount of water present, fluids containing very little water having low conductivities while those with high water contents showed high conductivities. Viscosities also showed a wide range.

4. *Addition of Water to Cause Turbidity in the Fluids.*

Experiments were carried out with several brands of tar-distillate fluids to determine the amount of water that may be added to these before incipient turbidity resulted. Certain of these allowed of much greater additions of water than others before turbidity was

produced. Fluids containing the maximum amount of water without showing turbidity became turbid on warming and cleared again on cooling.

5. *Changes in Properties on the Gradual Dilution with Water.*

On the gradual addition of water to tar-distillate fluids, followed by shaking, the fluids at first dissolved the water forming homogeneous solutions. As more water was added a point was reached where turbidity set in and at this point the mixtures tended to become unstable and to separate into two or three layers. One of the layers was always clear and pale brown in colour. It contained very little dispersed oil and seemed to be a solution of the tar acid in the soap solution. The other separated layer was either a thick oily layer or a cream, which sank or floated according to the specific gravity of the oil. When three layers were present both the oily layer and the creamy layer were present.

The mixtures of the tar oil fluids and water were stable when the concentration of the former did not exceed about 25%, this maximum concentration of the fluid depending on the composition of the oil. Below this concentration down to extreme dilution the emulsions obtained were stable.

A 30% emulsion was prepared and a part further diluted immediately with water. This diluted portion formed a stable emulsion. The concentrated emulsion on standing for a short time separated into layers. After this separation, the 30% emulsion was well shaken and diluted, but the diluted fluid formed in this way was unstable. The change in stability, on standing, is probably due to a change in the size of the emulsion particles. (*See below*).

The particles in the stable tar oil emulsions were found generally to be much smaller than most oil emulsions (except " pure " oil emulsions) being of the order of 0.1 μ in diameter with a few particles reaching 1 μ in size. In concentrated unstable tar oil emulsions, the particles were heterogeneous and varied in size from approximately 0.1 μ to several μ in diameter. They tended to coalesce on standing.

On diluting such emulsions the particle size remained unaltered and hence the resultant emulsions were unstable.

Neutral tar oil emulsions showed heterogenity of particle size and tended to cream.

6. *Stability of Tar Oil Emulsions.*

Experiments were carried out to discover the conditions necessary for obtaining stable emulsions on dilution with water from the concentrated tar oil fluids. These showed that many clear concentrated fluids yield on dilution unstable emulsions.

It was shown that in order to obtain stable emulsions, four conditions are essential :—

(*a*) The diluted emulsions should contain less than 25% of tar oil. (In field practice this would never be exceeded).

(*b*) An excess of soap over the minimum amount required to produce the clear fluids is generally essential.

(*c*) The choice of soap is governed to a large extent by the composition of the oil.

(*d*) The original tar oil should contain at least 15% of tar acid of the efficiency of cresol. (The upper limit of approximately 60% would never be exceeded in practice owing to the highly corrosive action of tar acids).

Castor oil soap was found to be the most efficient soap used in the investigation for the production of stable emulsions. Resin soap, although extremely efficient in producing clear concentrated solutions, was unsuitable when used alone for the preparation of the diluted fluids as the emulsions so formed tended to cream.

Castor oil soap alone gave the best results in the preparation of tar oil fluids when the tar acid content exceeded 15%, but a mixture of castor oil soap and resin soap in equal proportions was most efficient when the tar acid content was below 15%.

7. *Function of the Tar Acid in the Emulsions.*

The soap itself did not appear to act as the emulsifying agent for the tar oil emulsions. The tar acid seemed to be distributed between the disperse and continuous phases ; in the continuous phase it was combined with the soap forming an efficient emulsifying agent.

8. *Stability of Tar Oil Emulsions in the Presence of Electrolytes.*

Tests were made with diluted tar oil emulsions to ascertain how their stability was influenced by the presence of electrolytes. Solutions of salts of aluminium, calcium and magnesium, and of caustic soda and hydrochloric acid were used.

It was concluded from these that the emulsions are not particularly sensitive to electrolytes in moderate concentration and that the concentrations of these necessary to produce unstability are not likely to be encountered in natural waters.

Acknowledgments.

Thanks are due to Mr. F. Tutin for much advice and helpful criticism; also to the Chief Chemists of the Gas Light and Coke Company, the South Metropolitan Gas Company, and the Stavely Coal and Iron Company, for kindly supplying the desired fractions of vertical retort, horizontal retort and coke oven tars respectively.

CIDER-MAKING TRIALS FOR THE SEASON 1925-26.

By O. Grove.

As last year, the cider apple crop was decidedly below the average. This was especially the case with the Kingston Black variety, of which only very small quantities were available. The average specific gravity of all the juices made into cider at Long Ashton was 1.0519, which represents a very fair standard. The ciders themselves were judged on the Annual Tasting Day, May 6th, 1926, to be of fairly good quality, the acidities being rather high in the sharp class.

Single Variety Ciders.

In Table I will be found the analytical data and other observations concerning the season's single variety ciders.

Sharp Varieties.

Of the sharp varieties, No. 1, Red Norton, was tried for the first time. It produced a very fair cider of a pale colour and without much character. No. 2, Never Blight, gave a very useful sharp cider. The two next in the list, Red Dymock and Martin's Favourite, were similar in character, highly coloured, very sharp ciders with good flavour, very useful for blending with ciders made from sweet and bittersweet apples. No. 6, Porter's Perfection, gave a first-class cider. No. 7, Shrawley Sweet, which was tried for the first time was too high in tannin content to be used alone for cider, also the rate of fermentation of the sample was rather high. Nos. 8 and 9 were rather below the average for these two well-known varieties.

Sweet Varieties.

No. 10, Sweet Alford, the only representative of this class, was a very nice cider, very useful for blending with sharper varieties.

Bittersweet Varieties.

Of the bittersweet varieties the two first, Bramtot and Cherry Norman, gave ciders of good quality and body and the same can be said of Nos. 13 and 14. No. 15, White Jersey, was rather thin and without much character. Of the two Knotted Kernels, No 16 was the better, No. 17 being too bitter.

TABLE I.

SINGLE VARIETY CIDERS.

No.	Name of Variety.	District where grown.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C.	Date of Filtering.	Specific Gravity May, 1926.
	APPLES—								
	SHARP VARIETIES—								
1	Red Norton	Norton Canon, Her.	13/10/25	1.050	0.52	0.24	6.0	12/11/25	1.019
2	Never Blight	Long Ashton, Som.	19/10/25	1.039	0.61	0.19	10.0	28/10/25	1.019
3	Red Dymock	Stourport, Wor.	20/10/25	1.044	1.17	0.12	5.0	6/11/25	1.025
4	Martin's Favourite	,, ,,	17/10/25	1.042	1.18	0.08	5.7	27/10/25	1.027
5	Red Streak	Spetchley, Wor.	8/10/25	1.049	0.85	0.29	6.7	26/10/25	1.028
6	Porter's Perfection	Martock, Som.	13/11/25	1.048	0.68	0.26	3.8	18/12/25	1.030
7	Shrawley Sweet	Stourport, Wor.	3/11/25	1.052	0.57	0.59	9.0	16/12/25	1.031
8	Frederick	Raglan, Mon.	28/10/25	1.051	1.08	0.09	2.9	18/11/25	1.032
9	Kingston Black	Various	11/11/25	1.060	0.77	0.31	3.5	2/2/26	1.033
	SWEET VARIETIES—								
10	Sweet Alford	Long Ashton, Som.	19/10/25	1.043	0.29	0.16	7.3	6/11/25	1.013
	BITTERSWEET VARIETIES—								
11	Bramtot	Moorhampton, Her.	19/10/25	1.053	0.28	0.35	9.3	3/11/25	1.019
12	Cherry Norman	Long Ashton, Som.	19/10/25	1.043	0.26	0.34	5.3	9/11/25	1.022
13	Strawberry Norman	Long Ashton, Som.	16/11/25	1.045	0.34	0.43	5.6	7/1/26	1.022
14	White Norman	Nunnington, Her.	20/10/25	1.052	0.30	0.36	5.0	23/11/25	1.026
15	White Jersey	Long Ashton, Som.	1/10/25	1.049	0.20	0.22	3.2	9/11/25	1.027
16	Knotted Kernel	,, ,,	23/10/25	1.058	0.29	0.39	5.4	12/1/26	1.025
17	Knotted Kernel	Moorhampton, Her.	6/11/25	1.065	0.31	0.55	4.0	10/3/26	1.028
	CULINARY VARIETIES—								
18	Bramley's Seedling	Stockton, Wor.	28/10/25	1.043	0.94	0.16	9.0	9/11/25	1.021
19	Worcester Pearmain	,, ,,	28/9/25	1.056	0.59	0.18	12.0	5/10/25	1.000
20	,, ,,	Ledbury, Her.	28/9/25	1.051	0.53	0.18	13.0	5/10/25	1.001
21	,, ,,	Putley, Her.	28/9/25	1.060	0.59	0.17	8.5	5/10/25	1.010
22	,, ,,	Hownhall, Ross, Her.	9/10/25	1.060	0.56	0.21	3.2	29/12/25	1.026

Table Varieties.

The four samples of Worcester Pearmain were the most interesting of the table varieties, especially from the rate of fermentation point of view. The rates of fermentation varied from 3.2 to 13, this being principally due to the different soil conditions on which the fruit was grown. No. 22, with the lowest rate of fermentation, was by far the best cider.

Pure Yeast Fermentation Trials.

The pure culture fermentation experiments started last season on juices pasteurised with the new type of pasteuriser of French manufacture, described in last year's Report, were continued. The juice was in each case passed through the pasteuriser at a temperature of 160° F. and immediately afterwards on cooling a culture of pure yeast was added. In each series a control cask of unpasteurised, naturally fermented juice was kept for comparison with the pasteurised samples.

The yeasts used were the following, the name in brackets indicating the cider or wine from which the yeast had originally been isolated : Yeast No. 5 (Yellow Styre, 1912) ; No. 6 (Kingston Black, 1912) ; No. 9 (Sweet Alford) ; No. 12 (Symes' Sweet) ; No. 13 (Gatcombe) ; No. 19 (Strawberry Norman) ; No. 20 (Lambrook Pippin) ; No. 22 (Yellow Styre, 1915) ; No. 25 (Kingston Black, 1914) ; No. 27 (Johannesberg) ; No. 29 (Scharzhofberg) ; No. 31 (Rüdesheimer) ; No. 32 (Steinberg) ; No. 34 (Laureiro) ; No. 37 (Riesling) ; No. 42 (Port) ; No. 44 (Champagne) ; No. 45 (Champagne) and No. 46 (Port).

In Table II will be found the analytical data and other particulars of the pasteurised ciders.

It would occupy too much space to give a detailed description of each cider. Samples have been tried on several occasions by different cider experts and the general verdict was that no flavour due to the pasteurisation could be detected in any case, and that the influence of the different yeast types upon the flavours of the ciders was in many cases quite conspicuous. This was especially the case with the E. series, where all the five pasteurised samples differed from the control, each of them having a flavour of its own and in all cases superior to the control. In the B, C, D and F series, yeast No. 6 gave upon the whole the best results.

TABLE II.

PASTEURISED CIDERS.

CIDERS made from apples from Martock, Som. Juices pasteurised at 160°F. and fermented with Pure Yeasts.

No.	Name of Variety.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of fermentation at 25°C.	Date of Filtering.	Specific Gravity, May, 1926.	Remarks on Fermentation.
23	Mixed Apples B1	13/11/25	1.052	0.39	0.29	6.4	19/1/26	1.022	†
							19/2/26	1.024	Fermented Yeast No. 42
24	,, ,, B2	,,	,,	,,	,,	,,	3/2/26	1.024	,, ,, No. 46
25	,, ,, B3	,,	,,	,,	,,	,,	26/2/26	1.025	,, ,, No. 42*
26	,, ,, B4	,,	,,	,,	,,	,,	1/4/26	1.026	,, ,, No. 46*
27	,, ,, B5	,,	,,	,,	,,	,,	30/3/26	1.025	,, ,, No. 6*
28	,, ,, B6	,,	,,	,,	,,	,,	19/1/26	1.023	†
29	,, ,, C1	27/11/25	1.052	0.52	0.29	7.3	9/2/26	1.024	,, ,, No. 6
30	,, ,, C2	,,	,,	,,	,,	,,	8/3/26	1.024	,, ,, No. 22
31	,, ,, C3	,,	,,	,,	,,	,,	19/2/26	1.024	,, ,, No. 25
32	,, ,, C4	,,	,,	,,	,,	,,	26/2/26	1.025	,, ,, No. 44
33	,, ,, C5	,,	,,	,,	,,	,,	10/2/26	1.025	,, ,, No. 45
34	,, ,, C6	,,	,,	,,	,,	,,	29/1/26	1.022	†
35	,, ,, D1	1/12/25	1.054	0.43	0.35	8.0	12/2/26	1.025	,, ,, No. 5
36	,, ,, D2	,,	,,	,,	,,	,,	15/2/26	1.024	,, ,, No. 6
37	,, ,, D3	,,	,,	,,	,,	,,	1/2/26	1.025	,, ,, No. 12
38	,, ,, D4	,,	,,	,,	,,	,,	22/1/26	1.024	,, ,, No. 19
39	,, ,, D5	,,	,,	,,	,,	,,	29/1/26	1.025	,, ,, No. 44
40	,, ,, D6	,,	,,	,,	,,	,,	25/1/26	1.022	†
41	,, ,, E1	7/12/25	1.048	0.48	0.26	6.5	24/2/26	1.024	,, ,, No. 27
42	,, ,, E2	,,	,,	,,	,,	,,	22/2/26	1.023	,, ,, No. 29
43	,, ,, E3	,,	,,	,,	,,	,,	2/2/26	1.024	,, ,, No. 34
44	,, ,, E4	,,	,,	,,	,,	,,	16/2/26	1.024	,, ,, No. 37
45	,, ,, E5	,,	,,	,,	,,	,,	23/2/26	1.024	,, ,, No. 23
46	,, ,, E6	,,	,,	,,	,,	,,	25/1/26	1.023	†
47	,, ,, F1	10/12/25	1.048	0.62	0.26	6.5	29/3/26	1.025	,, ,, No. 6*
48	,, ,, F2	,,	,,	,,	,,	,,	9/3/26	1.024	,, ,, No. 9*
49	,, ,, F3	,,	,,	,,	,,	,,	17/3/26	1.024	,, ,, 13*
50	,, ,, F4	,,	,,	,,	,,	,,	29/3/26	1.025	,, ,, No. 20*
51	,, ,, F5	,,	,,	,,	,,	,,	12/3/26	1.025	,, ,, No. 31*
52	,, ,, F6	,,	,,	,,	,,	,,			

* Pasteurised after keeving. † Control (fermented naturally).

It will be seen that the pasteurised juices fermented much more slowly than the controls. Also in many cases a better clearing of the juice during the fermentation took place: this was especially the case with the samples fermented with yeast No. 6.

The New Fruit and Cider Competitions.

With the object of stimulating greater interest in the culture of cider fruit in farm orchards and of promoting the growing of varieties of cider apples which are of the highest value from the combined points of view of the grower and the cider-maker, a novel form of competition was held for the first time.

The competition took the form of actual cider-making trials at the Institute with the respective entries of fruit. The fruit (15 cwts. in each case) was stored under uniform conditions until fit for milling. Each lot was made up at approximately the same state of ripeness and the subsequent treatment of the juice was as nearly as possible the same for each entry in any given class.

All the ciders made from entries in the same class were filtered when the juice has fermented down to the following specific gravities: Class I, 1.028; Class II, 1.030; Classes III, IV and V, 1.025.

The competition was open to bona-fide growers resident in the counties of Devon, Dorset, Gloucester, Hereford, Monmouth, Somerset and Worcester.

Details of the entries will be found in Table III.

The ciders were judged on the 26th of April, 1926 by H. J. Davis, Esq., Sutton Montis, Somerset, R. E. Ridler, Esq., Clehonger, Hereford and W. Chapman Gaymer, Esq., Attleborough, Norfolk.

Judges' Report.

The judges reported as follows:—

"The ciders in these competitions were judged by us on Monday, April 26th, so that the awards could be announced on the occasion of the Annual Tasting Day, on Thursday, May 6th. So early a date in the season involved the drawback that the ciders were still comparatively immature and allowance was made for this in considering the awards.

TABLE III.

COMPETITION VARIETIES.

No.	Name of Variety.	Name of Grower.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity. May, 1926.	District where grown.
	CLASS 1.—Kingston Blacks—										
55	Kingston Black	R. E. Turner	2/11/25	1.072	1.66	0.29	5.8	11/1/26	1.028	1.027	Dymock, Glos.
56	,, ,,	D. Phillips Morgan	9/11/25	1.066	0.66	0.28	3.5	2/3/26	1.028	1.028	Tewkesbury, Glos.
57	,, ,,	W. Ridley Thomas	9/11/25	1.062	0.66	0.26	3.2	30/1/26	1.028	1.028	Nunnington, Her.
58	,, ,,	H. C. Davis	2/11/25	1.065	0.83	0.32	3.0	23/2/26	1.028	1.028	Hewish, Som.
	CLASS 2.—Sharp Varieties—										
59	Tom Tanners	J. W. Pullin	9/11/25	1.044	1.00	0.25	13.5	20/11/25	1.030	1.023	ComptonGreenfield,Glos.
60	Tom Putt	W. Maynard	26/10/25	1.048	0.67	0.18	10.6	2/11/25	1.030	1.024	Martock, Som.
61	Frederick	W. R. Williams	30/10/25	1.041	0.91	0.11	8.6	4/11/25	1.030	1.025	Hampton Bishop, Her.
62	Kernels	A. H. Templeman	16/11/25	1.055	0.92	0.25	—	11/1/26	1.030	1.026	Street, Som.
63	Bramley's Seedling	E. H. Wells	9/11/25	1.048	0.91	0.18	4.0	5/12/25	1.030	1.027	Wellington, Som.
64	Gatcombe	W. Butler	2/11/25	1.052	0.64	0.17	8.3	19/11/25	1.030	1.028	Long Ashton, Som.
65	Spice Apple	W. P. Merrett	17/10/25	1.045	0.85	0.09	11.0	24/10/25	1.030	1.028	Arlingham, Glos.
66	Cosadill	Clinch & Goddard	13/11/25	1.048	0.86	0.17	7.2	11/12/25	1.030	1.028	Upton-on-Severn, Wor.
67	Frederick	S. W. Mullins	27/10/25	1.051	1.08	0.09	2.5	28/12/25	1.030	1.029	Raglan, Mon.
68	Wagstaff	P. E. Bomford	26/10/25	1.058	1.04	0.20	7.0	14/12/25	1.030	1.029	Upton, Snodsbury, Wor.
69	Cap of Liberty	R. J. Denning	2/11/25	1.055	1.10	0.31	6.3	23/12/25	1.030	1.029	Ilminster, Som.
70	,, ,,	E. V. V. Wheeler	26/10/25	1.062	1.21	0.36	4.4	4/1/26	1.030	1.030	Tenbury, Wor.
71	,, ,,	G. W. Moody	9/11/25	1.053	0.72	0.30	2.4	4/1/26	1.030	1.030	Martock, Som.
72	Brice's Kernel	D. Phillips Morgan	22/10/25	1.046	0.74	0.20	6.0	3/11/25	1.030	1.030	Tewkesbury, Glos.
73	Yellow Styre	,, ,,	2/11/25	1.050	0.71	0.10	3.0	20/2/26	1.030	1.030	,, ,,
	CLASS 3.—Sweet Varieties—										
74	Sweet Blenheim	R. J. Denning	19/10/25	1.054	0.31	0.14	9.3	28/10/25	1.025	1.019	Ilminster, Som.
75	Eggleton Styre	F. C. Pole	17/10/25	1.048	0.44	0.16	8.0	27/10/25	1.025	1.021	Holmer, Her.
76	Ilminster Morgan Sweet	R. J. Denning	19/10/25	1.051	0.27	0.15	6.0	10/11/25	1.025	1.023	Ilminster, Som.

TABLE III.—*continued.*

COMPETITION VARIETIES.

	CLASS 4.—Bittersweet Varieties—										
77	Rough Thorn	E. V. V. Wheeler	29/10/25	1.052	0.27	0.32	9.2	12/11/25	1.025	1.020	Tenbury, Wor.
78	Prince Albert	V. J. Davis	22/10/25	1.051	0.24	0.32	9.0	31/10/25	1.025	1.023	Berkeley, Glos.
79	Dabinett	J. H. Symes	2/11/25	1.050	0.26	0.33	7.6	6/1/26	1.025	1.024	Martock, Som.
80	Strawberry Norman	W. R. Williams	30/10/25	1.048	0.41	0.42	7.5	17/11/25	1.025	1.024	Hampton Bishop, Her.
81	Broadleaves	W. Maynard	26/10/25	1.057	0.37	0.45	13.3	5/11/25	1.025	1.024	Martock, Som.
82	Belle Norman	D. Phillips Morgan	29/10/25	1.055	0.22	0.27	7.2	12/12/25	1.025	1.024	Tewkesbury, Glos.
83	White Norman	J. W. Pullin	20/10/25	1.055	0.33	0.32	6.1	7/12/25	1.025	1.025	Compton Greenfield,Glos.
84	Tom Tanners	H. C. Davis	2/11/25	1.063	0.37	0.68	3.8	12/2/26	1.025	1.025	Hewish, Som.
85	Loyal Drain	E. W. Dabinett	29/10/25	1.054	0.26	0.52	6.2	23/1/26	1.025	1.025	Kingweston, Som.
86	Jerseys	G. W. Moody	9 11/25	1.054	0.36	0.40	2.4	22/1/26	1.025	1.025	Martock, Som.
87	Sparkler	E. A. Austin	2/11/25	1.050	0.31	0.30	3.4	27/2/26	1.025	1.025	Baltonsborough, Som.
	CLASS 5.—Mixed Varieties—										
88	Belle Norman, Frederick, and StrawberryNorman	W. R. Williams	30/10/25	1.045	0.73	0.24	12.6	7/11/25	1.025	1.022	Hampton Bishop, Her.
89	Broadleaves, Cap of Liberty, Pound, Jerseys and Tommy Rodford	W. Maynard	26/10/25	1.054	0.52	0.39	10.3	11/11/25	1.025	1.022	Martock, Som.
90	Unknown	V. E. Naish	16/11/25	1.050	0.32	0.30	6.6	5/1/26	1.025	1.023	Yatton, Som.
91	Pip Georges, Painted Ladies, Berkeley Pippin Jelly Apples and Hangdown	E. Atherton	2/11/25	1.048	0.72	0.29	6.0	29/12/25	1.025	1.024	Long Ashton, Som.
92	Foxwhelp, Cap of Liberty Horners, Dabinett, and Jerseys	Scott & Gent	28/10/25	1.049	0.58	0.31	4.0	21/1/26	1.025	1.024	South Petherton, Som.
93	3 unnamed local varieties	Clinch & Goddard	13/11/25	1.050	0.41	0.20	6.0	7/12/25	1.025	1.024	Upton-on-Severn, Wor.
94	Cap of Liberty, Jerseys and Norton Bitters	G. W. Moody	10/11/25	1.055	0.48	0.35	2.7	21/1/25	1.025	1.024	Martock, Som.

TABLE III.—*continued.*

COMPETITION VARIETIES.

No.	Name of Variety.	Name of Grower.	Date of making.	Specific Gravity of Fresh Juice.	Malic Acid per cent.	Tannin per cent.	Rate of Fermentation.	Date of Filtering.	Specific Gravity at time of Filtering.	Specific Gravity May, 1926.	District where grown.
95	Normandy, White Beach, Red Wilding, Reynolds. Devon Sweets, Old Soldier and Styre	R. E. Turner ..	28/10/25	1.053	0.89	0.24	4.8	7/11/25	1.025	1.024	Dymock, Glos.
96	Brices Kernel Belle Norman and Cowarne Red	D. Phillips Morgan	3/11/25	1.051	0.58	0.27	7.0	28/12/25	1.025	1.024	Tewkesbury, Glos.
97	Tom Tanners, Meadyeats, Red Jersey and Hangdowns	H. C. Davis ..	2/11/25	1.050	0.58	0.42	2.6	2/3/26	1.025	1.025	Hewish, Som.
98	Loyal Drain, Cap of Liberty, Doves, Boon's Red, and Striped Norman	E. W. Dabinett	28/10/25	1.052	0.66	0.34	3.6	23/12/25	1.025	1.025	Kingweston, Som.
99	White Styre, Sweet Alford and Royal Wilding	W. P. Merrett ..	17/10/25	1.050	1.29	0.14	12.5	27/10/25	1.025	1.025	Arlingham, Glos.
100	Cap of Liberty Dabinett, Royal Jerseys and Horners	J. H. Symes ..	2/11/25	1.050	0.52	0.35	3.6	16/2/26	1.025	1.025	Martock, Som.

Of the five classes into which the ciders were divided, Class I was for the variety Kingston Black. None of the four entries was really typical of this variety and all were considerably below its best standard. Since the 1925 crop was very scarce, this result was not unexpected.

Class II was composed of single variety ciders made from apples of the sharp class, Class III of single varieties of the sweet class, and Class IV of single varieties of the bittersweet class. In each of these no attempt was made to judge the ciders as finished products, since from the nature of the classes it was obvious that suitable blending would be required to furnish a commercial article. This fact was allowed for and the ciders were judged from the standpoint of their value to the cider-maker, if appropriately blended.

Class II may be rated as a strong class for the season, both in number of entries and quality. Every exhibit could be considered as worthy of mention. The quality throughout was generally very level and it was difficult to decide upon the order of merit.

Class III contained only three entries. None were outstanding in character, but each was a fair type for the class for the season.

Class IV was another strong class, numerically and in quality. Practically every entry with suitable blending could be converted into a useful commercial cider.

Class V composed of ciders made from mixed varieties of apples, selected and blended in proportions by the individual exhibitors, was strong in number of entries, but disappointing in quality. Few of the ciders approached a suitable commercial standard, the fault mainly resting in the proportions of the respective varieties selected for the blends. In most cases the bittersweet tannin character was too pronounced.

We consider that in view of the short apple crop of 1925, a very encouraging start has been made with these competitions and we are impressed, both from the general character of the ciders themselves and the absence of any taints, by the extremely fair and equal treatment given during the making to all samples, thus enabling every entry of fruit to be judged fairly on its own merits.

The list of awards is as follows :—

Class 1. KINGSTON BLACK.

Equal First	*	56	D. Phillips Morgan, Tewkesbury, Glos.
		57	W. Ridley Thomas, Nunnington, Her.
Reserve		58	H. C. Davis, Howish, Som.

* The numbers stated refer to the ciders described under the corresponding numbers in Table III.

Class 2. SHARP VARIETY.

First Prize	67	S. W. Mullins, Raglan, Mon.
Second Prize	68	P. E. Bomford, Upton Snodsbury, Wor.
Reserve	64	W. Butler, Long Ashton, Som.
Highly Com.	69	R. J. Denning, Ilminster, Som.
Commended	61	W. R. Williams, Hampton Bishop, Her.
Commended	63	E. H. Wells, Wellington, Som.

Class 3. SWEET VARIETY.

First Prize	76	R. J. Denning, Ilminster, Som.
Equal Second	74	Ditto.
	75	F. C. Pole, Holmer, Her.

Class 4. BITTERSWEET VARIETY.

First Prize	79	J. H. Symes, Martock, Som.
Second Prize	83	J. W. Pullin, Compton Greenfield, Glos.
Reserve	82	D. Phillips Morgan, Tewkesbury, Glos.
Highly Com.	80	W. R. Williams, Hampton Bishop, Her.
Ditto	81	W. Maynard, Martock, Som.
Commended	78	V. J. Davis, Berkeley, Glos.

Class 5. MIXED VARIETIES.

First Prize	93	Clinch & Goddard, Upton-on-Severn, Wor.
Second Prize	100	J. H. Symes, Martock, Som.
Third Prize	98	E. W. Dabinett, Kingweston, Som.
Reserve	96	D. Phillips Morgan, Tewkesbury, Glos.
Very Highly Com.	95	R. E. Turner, Dymock, Glos.
Commended	91	E. Atherton, Long Ashton, Som.
Commended	92	Scott & Gent, South Petherton, Som.

THE USE OF SULPHUR DIOXIDE AS A PRESERVATIVE IN CIDER.

By B. T. P. Barker and O. Grove.

At the outset it should be stated that cider can be made without any special processing or unusual methods to keep in sound condition for a practically unlimited length of time. No added preservatives are necessary and there are many makers who never use them. At the Institute thousands of samples have been made from the most diverse types of cider apples without the aid of such substances and without any difficulty on the score of keeping quality: it is only in occasional instances and with certain classes of apples that disorders have developed.

In the face of this declaration it may well be asked why the addition of preservatives should not be absolutely prohibited and why recent legislation has given official sanction to the use of one particular form. The latter development has already involved the Institute in investigations and discussions, official and private, concerning both the political and technical side of this subject, and it is inevitable that it should be even more associated with it in future. The writers of the present article feel, therefore, that this opportunity should be taken to state the attitude of the technical staff at the Institute, which they represent, before proceeding to any detailed account of work on preservatives for cider which has been done in the past or may be done in the future.

As stated in the opening paragraph, it is their view that good, sound, long-keeping cider can be made without the use of any added preservative. It may indeed be further added that, provided the maker is in a position to control the conditions under which the cider is kept until consumption, there is, in their opinion, no justification for such additions.

On the other hand it has to be recognised that the cider industry has completely passed the phase when it was a local industry pure and simple, and when consumption was confined to the maker's premises or in the near vicinity in such a manner that he could control the conditions of storage almost up to the actual time of consumption. To-day cider is distributed far from the centres of production and is sent to all parts of the world in the course of export trade. From the time the finished product leaves

his cellars the maker may completely lose subsequent control of the conditions to which it is subjected in the ordinary course of trade and in most cases must perforce be unaware of the vicissitudes to which it is exposed before consumption.

Now it is incontestable that the ordinary cider is a beverage of unstable and ever-changing character owing entirely to its nature and composition. It normally contains decomposable material among its natural constituents and possesses no inherent natural preservative in effective quantity. It follows therefore that, unless it is kept under appropriate conditions, changes may be induced which cause more or less serious deterioration. Even when storage conditions are as good as can reasonably be expected, there is an ever-present risk of this happening.

Regarded from the purely commercial point of view, it is essential that such risks should be entirely eliminated if possible, and certainly reduced to order of a remote possibility, if the article is to be accepted as one on which a stable industry can be built up.

Taking all these points into consideration, it is contended that the addition of a suitable form of preservative to cider can be justified in the case of this beverage as in the case of any other perishable article, when the cider-maker in the ordinary course of his business finds such addition necessary as a safeguard against risk of decomposition before consumption.

The New Regulations on Preservatives.

The two most commonly employed preservatives have hitherto been sulphur dioxide and salicylic acid. Under the new regulations of the Ministry of Health which came into force on January 1, 1927, the latter is now prohibited in cider and the only preservative permitted from that date is sulphur dioxide, the maximum amount allowed being 0.02 per cent. (1 part in 5,000 parts), i.e., 14 grains per gallon (3.2 oz. per 100 gallons) of total sulphur dioxide.

However desirable it may be to dispense altogether with preservatives in the making of cider, the use of sulphur dioxide within the limit given above cannot be open to very serious objection. It has been used in the making of wines and cider for centuries and is considered harmless from the health point of view in such small quantities as are under consideration here.

In view of the legislation on the use of sulphur dioxide within the limits specified, it is clear that the Institute will receive from the cider industry enquiries concerning various technical points involved in its use. Many in fact have already been sent in.

Apart from general advice which has been given to enquirers, information on specific points has been provided as the result of experimental work undertaken in connection therewith. In the face of this demand for information it may be useful to include from time to time in the Annual Reports some account of the various questions which have come under consideration and have been investigated.

The present article reviews the position with regard to a number of such questions which have already been raised. It necessarily contains much that is common knowledge among many who have had occasion to deal with sulphur dioxide previously; but for the benefit of those who have not, matter has been included which would not normally be presented in detail in a paper concerned primarily with research.

Modes of Use of Sulphur Dioxide.

Sulphur dioxide can be applied in cider making in three different ways: (1) by burning sulphur and allowing the cider to absorb the sulphur dioxide so formed, (2) by direct addition to the cider as pure sulphur dioxide, and (3) by addition in the form of potassium, sodium or calcium salts of sulphur dioxide.

(1) In the first case gaseous sulphur dioxide is produced by burning sulphur, either in sticks, in powder form, or as the so-called sulphur matches, in casks or other enclosed vessels containing cider or about to be filled with cider. When sulphuring large vats or tanks sulphur in sticks or as powder may be used. It is put in a small container of iron or other metal, which is suspended by means of steel wires—not copper—in the vat, the sulphur is ignited and the vat closed to prevent the escape of the gas.

Sulphur matches are more convenient for smaller casks. They are easily made by dipping strips of calico in molten sulphur. The sulphur should be melted slowly and kept at a comparatively low temperature. If heated too much it turns dark in colour and assumes a viscous consistency. The match is introduced into the cask after placing it in a small wire cylinder with a cup-shaped bottom, so as to prevent any sulphur dripping in the cask; or it can be tied with thin wire to a piece of stout wire, which has at its end a small metal receptacle (a shaving-soap tin will do). The sulphur is then set alight and the cask lightly bunged. The burned-out match is then withdrawn from the cask

before introducing the juice or the cider; care should be taken that in doing so all the incinerated parts of the match are removed.

The disadvantage of these methods of introducing sulphur dioxide is that it is impossible in practice to control the exact quantity of the substance absorbed by the juice or cider. When sulphur burns in air, one part of sulphur combines with an equal weight of oxygen taken from the air and two parts of sulphur dioxide are formed; thus, one ounce of sulphur completely burned produces two ounces of sulphur dioxide. It is therefore a simple matter to calculate the amount of sulphur to burn to get any desired amount of sulphur dioxide. The difficulty is, however, that the whole of this substance is not absorbed by the juice or cider.

In considering how to deal with this difficulty in face of the limitations now imposed by the Ministry of Health it occurred to the writers that there might be some approximate relation between the amount absorbed by the liquor and that remaining unabsorbed in the air-space in the cask. To obtain information on this point the following experiments were made.

The first experiments were conducted in the laboratory with small amounts of juice in glass containers. In one set of experiments a small weighed quantity of sulphur was burned in a flask with a content of $2\frac{1}{2}$ litres. Immediately after the combustion of the sulphur the flasks were filled with apple juice and the sulphur dioxide in the juice determined. The average amount of sulphur dioxide taken up by the juice was 58 per cent. of the total amount of sulphur dioxide present in the flask as the result of the burning of the sulphur.

In another set of experiments 100 cc. of juice and 500 cc. of juice respectively were placed in the flask before burning the sulphur and after combustion the flasks were immediately filled with juice. Under these conditions it was found that it did not matter much whether 100 cc. or 500 cc. were placed initially in the flasks; in both cases an average of 76 per cent. of the total sulphur dioxide produced was absorbed by the juice.

The same types of experiments were repeated on a larger scale in the cider house. In the first case 58.15 grams sulphur were burned, (corresponding to 116.3 grams sulphur dioxide), in a wet 100 gallon cask and the cask was immediately afterwards filled with juice. The juice was found to contain 55.79 grams of sulphur dioxide, or 47 per cent. of the total. In other experiments 10 gallons of juice were put in the cask before burning the sulphur, with the result that 71 per cent. of the total sulphur dioxide was absorbed by the juice.

The laboratory experiments were consequently nearly confirmed under practical conditions in the cider house. The statement that about 50 per cent. of the possible sulphur dioxide is absorbed by the juice when sulphur is burned in the empty and wet cask and that about 75 per cent. of the sulphur dioxide is absorbed when the cask contains about one-tenth of the juice before burning, will be found fairly correct in practice, although minor variations should be allowed for.

(2) The second way of using sulphur dioxide is by direct addition in its pure form. It is a gas easily condensed by pressure into a colourless liquid, and can be obtained in commerce as such in glass syphons or steel cylinders. In France several different types of measuring apparatus are on the market. They generally consist of a steel container connected with a small graduated glass-cylinder, in which the liquid sulphur dioxide can be measured under pressure in any quantity wanted. After measuring the liquid, the cylinder is connected with a piece of glass or tin tubing, the other end of which is inserted into the juice or cider. When the tap is opened the measured quantity of the liquid sulphur dioxide volatilises and passes as a gas into the juice, where it is immediately absorbed. With an apparatus of this description it is a simple matter to dose the liquid exactly with any quantity of sulphur dioxide wanted.

(3) A third method is also available. It consists in using a salt of sulphur dioxide. There are several possible salts to select from, such as bisulphite of soda, bisulphite of potassium and bisulphite of lime.

Bisulphite of soda cannot be recommended. Sodium compounds are present in apple juice in very small quantities only, and salts of that element are liable to

produce deposits and have undesirable effects on the flavour.

Potassium salts are preferable and the best of them for general use is undoubtedly potassium meta-bisulphite. This salt is obtainable in the form of small crystals, which contain, when pure, 57.6 per cent. of sulphur dioxide. The ordinary article of commerce contains, however, only about 55 per cent. of sulphur dioxide. When using the commercial product in practice it is generally taken to contain 50 per cent. of sulphur dioxide. Therefore, an amount of the salt twice the weight of the quantity of sulphur dioxide required may be used, which means, under the regulations, a maximum dose of 28 grains of potassium meta-bisulphite per gallon (6.4 oz. per 100 gallons). It may be added to the cider in solid form and in that case the juice or cider should be stirred up about 24 hours after its addition; or it can first be dissolved in a little warm water before addition.

The calcium salt, bisulphite of lime, is sold in liquid form and has the disadvantage that the content of sulphur dioxide is variable. Otherwise there is no serious objection to using this salt as a source of sulphur dioxide.

Sometimes sulphurous acid, which is a solution of sulphur dioxide in water, is used. The objection to sulphurous acid is the same as in the case of bisulphite of lime, viz., that the content of sulphur dioxide is variable.

The use of potassium meta-bisulphite is probably the most convenient and the most exact method of sulphuring for the small maker. Works on a larger scale will find the liquefied gas previously referred to more economical and it has also the advantage that nothing but sulphur dioxide is introduced. There can, however, be no material objection to the introduction of small quantities of the potassium compound in the cider, since other potassium salts are already present.

Estimation of Sulphur Dioxide.

The method used for the quantitative determination of sulphur dioxide in the experiments just mentioned and in experiments mentioned later was the following. 50 cc. of the juice or cider are measured into a distillation flask and 20 cc. of a 20 per cent. solution of glacial phosphoric acid are added. The distillation flask is

connected with an apparatus generating carbonic acid gas and with a cooling condenser, to which is attached a peligot-tube with both bulbs filled to about one-third with a weak solution of iodine. After passing a stream of carbonic acid gas through the whole apparatus the distillation flask is gently heated and distillation continued until about 10 cc. are left. The stream of carbonic acid gas is kept going during the distillation. After the distillation the iodine solution is washed out of the peligot-tube into a beaker: after addition of a few drops of hydrochloric acid the solution is boiled until colourless. To it is then added more hydrochloric acid and barium chloride. It is then boiled for 15 minutes. After keeping the beaker in a warm place for 24 hours, the barium sulphate is separated by filtration, ignited and weighed in the usual way.

Modes of Action on Apple Juice and Cider.

Sulphur dioxide acts directly upon the micro-organisms in the cider, checking or hindering their development. Hence its preservative effect. To stop the fermentation completely a much higher dose than the maximum allowed, 0.02 per cent., is necessary.

The checking action varies with different juices and ciders, depending on the content of nitrogenous material in the juice. It is well known that some juices contain less nitrogenous food for the yeast than others, and consequently have a slower rate of fermentation. In such juices even a dose of 0.02 per cent. of sulphur dioxide will sometimes stop fermentation nearly completely for a considerable time: therefore care must be taken in adding sulphur dioxide to juices of this description.

The check upon the rate of fermentation is seen from the following experiments.

To a number of flasks, each containing $2\frac{1}{2}$ litres of freshly pressed juice, were added at the outset varying amounts of sulphur dioxide (Series A). Other similar flasks of juice were left to ferment for six days and then the juice was racked from the yeast deposit into other similar flasks and sulphur dioxide added in the same quantities as above (Series B). In Series C half the dose of sulphur dioxide was added at the outset, the other half being added after racking. The flasks were closed with a fermentation lock and kept at room temperature, the specific gravities being taken at regular intervals.

Table I. sets out the results in detail.

TABLE I.

Series	No.	% of *Sulphur dioxide added. at start.*	Specific gravity at start.	Specific gravity after 1 week.	% of *Sulphur dioxide added. after 1 week.*	Specific gravity after 2 weeks.	Specific gravity after 3 weeks.	Specific gravity after 4 weeks.	Specific gravity after 5 weeks.	Specific gravity after 6 weeks.	Specific gravity after 7 weeks.
A. Sulphur dioxide added immediately	1	*Control*	1.047	1.035		1.023	1.010	1.000			
	2	*0.010*	1.047	1.038		1.024	1.011	1.001			
	3	*0.015*	1.047	1.039		1.026	1.014	1.003			
	4	*0.020*	1.047	1.041		1.029	1.016	1.005			
B. Sulphur dioxide added after racking	1		1.034	1.023	*Control*	1.011	1.006	1.003	1.002	1.000	1.000
	2		1.034	1.033	*0.010*	1.030	1.028	1.025	1.020	1.018	1.013
	3		1.034	1.034	*0.015*	1.033	1.031	1.030	1.026	1.024	1.020
	4		1.034	1.034	*0.020*	1.034	1.034	1.033	1.030	1.029	1.024
C. Half the sulphur dioxide added immediately, the other half after racking	1	*Control*	1.047	1.034	*Control*	1.024	1.013	1.007	1.003	1.001	1.000
	2	*0.005*	1.047	1.037	*0.005*	1.028	1.019	1.010	1.005	1.002	1.000
	3	*0.0075*	1.047	1.038	*0.0075*	1.032	1.024	1.015	1.009	1.003	1.001
	4	*0.010*	1.047	1.040	*0.010*	1.034	1.027	1.020	1.013	1.005	1.002

It will be seen from Series A that the effect of the sulphur dioxide upon the fermentation of the juice, which was of the quick fermenting type, (rate of fermentation at 25° C. 10), was not very striking in this case. Even the maximum amount, 0.02 per cent., (14 grains per gallon), did not check the fermentation to a very considerable extent.

When considering the rates of fermentation in Series B quite another picture presents itself. In this case, where the juice had been deprived of the first yeast crop by racking after 6 days, the subsequent addition of sulphur dioxide has a very marked effect. In the case of No. 4 (the maximum dose) the juice took over two months to ferment from a specific gravity of 1.034 down to 1.010 at room temperature.

In Series C the checking effect was not nearly so pronounced.

The Fate of Sulphur Dioxide in Cider.

The whole of the sulphur dioxide does not remain as such in the juice or cider, but combines to a certain extent with different constituents of the juice, especially with the sugars and aldehydes, and a certain percentage is oxidised into sulphuric acid.

To find the rate of disappearance of the sulphur dioxide, twelve $2\frac{1}{2}$ litre flasks were filled with an unfiltered, once racked cider showing the following analysis :— specific gravity 1.039, malic acid 0.21%, tannin 0.15%, alcohol 0.8%, rate of fermentation of juice at 25° C. 3. They were dosed with varying amounts of sulphur dioxide, closed with a fermentation lock and kept in darkness in the cellar.

Table II. shows the rates of fermentation and the amounts of residual sulphur dioxide in the respective cases.

It will be seen that the rate of fermentation of this naturally slow fermenting juice was very considerably checked by the addition of sulphur dioxide. As regards the loss of sulphur dioxide it varied from 7 per cent. to 27 per cent., the average loss being 16 per cent. The loss was proportionately higher in the low concentrations (Nos. 1 to 4), than in the higher concentrations.

With the doses of sulphur dioxide permitted, (up to and including No. 7), it will be safe to reckon on an average loss of about 15 per cent.

TABLE II.

No.	% *Sulphur dioxide added.*	Specific gravity at start.	Specific gravity after 1 week.	Specific gravity after 3 weeks.	Specific gravity after 5 weeks.	Specific gravity after 7 weeks.	Specific gravity after 9 weeks.	Specific gravity after 12 weeks.	% *of Sulphur dioxide left.*
0	*Control*	1.039	1.033	1.032	1.028	1.022	1.016	1.011	—
1	*0.005*	1.039	1.034	1.033	1.028	1.023	1.016	1.012	*0.0037*
2	*0.0075*	1.039	1.034	1.033	1.028	1.022	1.016	1.011	*0.0053*
3	*0.010*	1.039	1.035	1.034	1.029	1.023	1.017	1.012	*0.0081*
4	*0.0125*	1.039	1.037	1.036	1.033	1.029	1.023	1.020	*1.0103*
5	*0.0150*	1.039	1.038	1.038	1.036	1.033	1.030	1.026	*0.0130*
6	*0.0175*	1.039	1.039	1.038	1.037	1.034	1.031	1.028	*0.0142*
7	*0.0200*	1.039	1.039	1.039	1.037	1.034	1.032	1.028	*0.0174*
8	*0.0225*	1.039	1.039	1.039	1.037	1.035	1.032	1.030	*0.0190*
9	*0.0250*	1.039	1.039	1.039	1.038	1.036	1.033	1.031	*0.0233*
10	*0.0275*	1.039	1.039	1.038	1.038	1.037	1.033	1.032	*0.0240*
11	*0.0300*	1.039	1.039	1.039	1.038	1.037	1.033	1.032	*0.0275*

From the flavour point of view it was observed that the characteristic flavour of sulphur dioxide, which is easily distinguished in the early stages, could not be detected in the samples Nos. 1 to 7 after 12 weeks ; in sample No. 8 the flavour was just distinguishable then, and in Nos. 9, 10 and 11, it was easily detected.

A similar experiment was carried out with bottled cider. A blend of different ciders (analysis : specific gravity 1.019, malic acid 0.44%, tannin 0.21%, alcohol 3.4%) was bottled with the addition of varying amounts of sulphur dioxide, (A), and potassium meta-bisulphite, (B). The bottles were kept in the cellar and the contents of sulphur dioxide determined after about four months keeping.

The results are stated in Table III.

TABLE III.

No.	A.		B.	
	% Sulphur dioxide present		% Potassium meta-bisulphite present at start	% sulphur dioxide present after 4 months
	at start	after 4 months		
1	0.005	0.0037	0.010	0.0037
2	0.0075	0.0059	0.015	0.0054
3	0.0100	0.0093	0.020	0.0081
4	0.0125	0.0108	0.025	0.0103
5	0.0150	0.0114	0.030	0.0114
6	0.0175	0.0141	0.035	0.0147
7	0.0200	0.0180	0.040	0.0163
8	0.0250	0.0201	0.050	0.0212
9	0.0300	0.0256	0.060	0.0251

The potassium meta-bisulphite used contained 55 per cent. sulphur dioxide and its weight added was exactly double that of the corresponding sulphur dioxide. The loss of sulphur dioxide during storage was similar in both cases, the average being about 17 per cent. in both cases.

As regards the influence of the addition of sulphur dioxide and potassium meta-bisulphite upon the flavour of the bottled cider, the results were the same as in the experiments described above, viz., that only the doses above the maximum permitted (0.02% and 0.04% respectively) gave a flavour of sulphur dioxide that could be detected easily after the period of storage.

As to the most effective time of adding the sulphur dioxide, the best result as far as the checking of the fermentation is concerned, is obtained when the addition takes place after keeving or the first racking—generally 6-8 days after making—but there is also

something to be said for adding it in two stages, *e.g.* three-fourths of the dose after keeving and one-fourth to the finished cider in the early spring. This last method would probably increase its action against the development of bacteria in the finished cider.

For unfiltered draught cider another procedure might be found useful in many cases. To a quantity of the freshly pressed juice might be added five times the maximum permitted (0.1% sulphur dioxide or 0.2% potassium meta-bisulphite, corresponding to 1lb. sulphur dioxide or 2lbs. potassium meta-bisulphite per 100 gallons); this will completely stop fermentation and the juice can be kept substantially unchanged for many months. This unfermented juice might then during the following summer be mixed, in suitable proportions, with dry cider, made in the usual way without any addition of sulphur dioxide, so that the content of sulphur dioxide in the mixture as a whole does not exceed the permitted amount. If, for example, the juice has had added to it five times the maximum permissible dose, one part of this preserved juice should be mixed with four parts of the dry cider, to which no sulphur dioxide has been added.

INVESTIGATIONS IN WILLOW CULTURE AND THE UTILISATION OF BASKET WILLOWS.

(Progress Report).

By H. P. Hutchinson.

The scheme for research and advisory work to aid the development of the basket willow industry in this country, made possible by a special grant from the Ministry of Agriculture, has now been in operation at Long Ashton for four and a half years, and has been developed sufficiently to justify a preliminary general account of the work which has been undertaken. The following progress report has therefore been prepared.

Research and Experimental Work.

The research and experimental work has included (*a*) the collection and testing of a wide range of varieties of willows, (*b*) the raising of new varieties, (*c*) a study of the manurial requirements of the willow, (*d*) comparative trials of different types of sets for propagation. (*e*) an investigation on methods of preparation of the rods for use and (*f*) studies on the insect and fungus enemies of the willow and disease control methods.

(*a*) *Variety Tests.*

As a first stage in the work variety trial beds were planted at the Research Station in the winter months of 1922-23. The land selected for the purpose was old pasture ; it was prepared for the crop by being hand dug to a depth of 12-16 inches. The number of varieties originally planted has been increased annually and now amounts to 110. This number comprises all varieties grown extensively in this country for commercial purposes and others, collected from various sources, which seemed to possess useful characters.

The variety trial plots have served the following purposes :—

(1) The methods of cultivation of the crop have been demonstrated.

(2) Willow growers have been able to select varieties suitable for their particular purposes.

(3) A source of willow sets for distribution to growers in England, Wales, Scotland and the Colonies has been provided.

(4) Suitable material has been readily available for the study of insect and fungus diseases.

(5) Information has been obtained and recorded on the habits of growth, and the quality and quantity of rods of the several varieties.

(6) A classification of the varieties, based on size of rods, quality, earliness and lateness of spring growth, and peeling properties has been possible.

The variety trial beds have been cultivated intensively with the above objects in view and, consequently, it has not been possible hitherto to adopt a system of cultural treatment where commercial methods of production might be tested. As this aspect is regarded as an important part of the general enquiry into the subject it is proposed to plant 3 acres of adjoining land which will admit of different types of commercial practice being tested.

(*b*) *The Raising of New Varieties.*

Although good varieties of willows suitable for the making of all kinds of basketry are grown in this country, the raising of new varieties from seed may produce willows of exceptional merit.

"New varieties," which might more correctly be regarded as strains, arise as vegetative "sports," but the characters which they possess do not appear to be fixed since such sports frequently produce rods like those of the stock from which they were originally taken.

As there are indications that some of the finest varieties are deteriorating while others have passed out of cultivation, it would appear to be wise policy to endeavour to maintain at least the present standard of production by introducing new varieties to the industry.

The year 1925 was favourable to the production of willow seed on the Station's beds. The seed of 14 varieties was gathered and sown, but owing to lack of knowledge of suitable conditions for germination and early growth, seedlings of five varieties only were ultimately raised. Of the several hundreds of young seedling plants now surviving selections will be made on the line of suitability for the various basket-making purposes.

Attempts were made in 1926 to obtain hybrids from parents having excellent rod characters on one side and disease resisting

characters on the other so as to obtain an individual combining in itself the two required parental characters. So far these efforts have failed owing to unfavourable weather conditions at flowering time, and to the fact that the flowering periods of the two proposed parents do not closely synchronise. These initial difficulties in the work have yet to be overcome.

(*c*) *Manurial Requirements of the Willow Crop.*

Prior to the commencement of this work information in regard to this factor in cultivation was scanty. As a rule the willow crop is grown on low-lying rich land where, for many years, applications of fertilisers may not be required. Manurial deficiency ultimately occurs as shown by diminished yields after grubbing, cleaning and replanting.

Experimental work has been carried out on the subject, the plants under treatment being kept under close control for three successive seasons. The results have enabled the conclusions to be drawn that deficiencies in nitrogen and phosphorus are mainly responsible for loss in fertility. Support for these conclusions was obtained subsequently from field experiments.

(*d*) *The Relative Value of Willow Sets.*

Experiments have been carried out to test the relative values of willow sets of different lengths, sets 6in., 9in., 12in., 15in. and 18in. lengths being used for the purpose. The results of two consecutive year's records have indicated that generally the amount of yield in rods is directly proportional to the length of set taken, but sets between 9in. and 12in. in length give the best economical results.

In another experiment no difference of economic consequence was found to exist where sets of the same length were planted at depths of 6in., 9in. and 12in.

There exists amongst practical growers a difference of opinion as to the relative values of sets taken from one and two year old wood. This problem was submitted to experiment in 1926. The results so far obtained are in favour of the two-year-old cuttings.

(*e*) *Preparation of Rods for Use.*

(1) *Peeling of Rods.*

The peeling of rods is one of the most costly items in the preparation of willows for market.

In peeling for "Buff" the present method is to boil rods for several hours in tanks constructed and fixed specially for the purpose. The fuel consumption is wasteful and the output of

peeled rods is slow. Laboratory experiments, using steam-heated water, and steam under different temperatures and pressures have been carried out. The results were favourable to the method of steam-heated water and the erection at the Station of a buffing installation based on the principle is now in progress.

In peeling for " White " a machine has been obtained, and will be tested on the 1926-27 crop.

(2) *Grading, Sorting and Tying.*

Different methods of grading, sorting and tying, now employed in different districts have been noted with the object of simplifying and reducing the costs of these operations.

(*f*) *Insect and Fungus Enemies of the Willow and Their Control.*

(1) *Insect Pests.*

In collaboration with the Research and Advisory Entomologists at the Station, a considerable amount of time has been devoted to investigations on this subject—chiefly in the direction of effecting remedies at the lowest costs.

In the case of Beetle attacks various preparations have been applied to affected crops with partial success. The trials have demonstrated that complete control is unlikely to be secured by the application of spray fluids alone to the growing crop. It has been found that paraffin emulsions properly prepared and applied, are effective to a large extent, but should be supplemented by methods of trapping, destruction of adult beetles when hibernating and, where possible, by allowing poultry to stray through the growing crops.

Excellent results have been obtained in the control of aphis after extensive trials. Nicotine preparations are effective but too costly. Experiments have proved that oil emulsions give satisfactory results. Rape oil emulsion is now being recommended to growers, since it may be prepared and applied at about one-quarter the cost of nicotine preparations.

(2) *Fungus Diseases.*

Experiments on these diseases have been carried out in collaboration with the Station's Advisory Mycologist. These will be described in detail in due course.

The great difficulty in dealing with all fungus diseases of the willow arises from the fact that the necessarily close method of planting, with the attendant difficulties of access to the crop, and comparatively warm moist conditions in the beds during the grow-

ing season is exceptionally favourable to the spread of the fungus when an attack occurs. Fungicides such as Bordeaux mixture check spread of the disease, but on a growing crop all liquid preparations are difficult to apply. Where new planting is being carried out, especially in new areas, growers are particularly advised to obtain their sets from disease-free crops.

Advisory Work.

The position of Willow Officer entails a considerable amount of work in connection with the giving of advice to growers in regard to crop problems. Particulars of this will be found in the Report on Advisory Work included in the present volume.

Many inspections of new land for willows have been made for Public Authorities on Water Works and Sewage Farms, and for private owners in different parts of the country and successful new centres of willow cultivation have arisen as a result of advice given.

The following articles have been published.

(1) The Basket Willow Crop as a Means of Utilising Wet Land. (Bath and West Journal, 1924-25).
(2) The Manurial Requirements of the Basket Willow Crop.
(3) The Buffing of Willows.
(4) Willow Growing as a Garden Crop.

The officer is in close touch with the Rural Industries Bureau, Rural Community Councils and Women's Institutes, by whom his advice is frequently sought.

REPORT ON ADVISORY WORK 1925-26.

Once again the number of enquiries dealt with during the year shows an increase on the previous years. It is interesting to note that the increase is largely due to enquiries from counties which have usually sent in the smallest number of enquiries.

There is a large increase in the number of milk samples dealt with. The dairy bacteriology work has increased so rapidly during the year that it has been found necessary to provide an extension to the milk laboratory. The University has provided a very useful, well lighted and well situated room for this work.

Two courses on " Clean Milk," for Sanitary Inspectors, have been provided at the University during the year.

The following table gives a list of enquiries dealt with during the past six years :—

	Year ending September 30th.					
	1921.	1922.	1923.	1924.	1925.	1926
Gloucester (including Bristol) ..	73	78	136	137	194	262
Hereford	22	21	62	107	88	91
Somerset	96	114	141	130	395	276
Wiltshire	10	18	66	24	117	175
Worcester	45	56	48	78	78	103
Other areas	125	201	205	195	222	309
Totals ..	371	488	658	671	1094	1216

Included in the figures under " other areas " are enquiries received from Devon and Monmouth, both of which counties contribute annual grants to the Long Ashton Institute, although not forming part of the Bristol Province.

This list does not include a considerable number of general agricultural enquiries which have been dealt with by the Chief Advisory Officer, many of which have involved visits to farms in the Province. The figures given have reference only to enquiries which have been dealt with by correspondence, and do not include a large number dealt with in personal interviews at shows, etc.

Enquiries relating to fruit and vegetable preservation are not included in these statistics. Advisory work on this subject is dealt with in the report of the Campden Station.

During the year full use has been made of the Provincial Advisory Conference and once again a Joint Meeting with the corresponding body from the West Midland Province has been held. One of

the most important results of these Conferences is the co-ordinating of county experimental work, which includes manurial trials, variety trials and spraying trials on fruit trees. In much of this work the West Midland Province has also co-operated.

Perhaps special attention should be directed to the report by the Adviser in Agricultural Economics. The provision of an additional student assistant in Economics has enabled the Adviser to undertake seriously the work offered by the Wiltshire Accounting Society. One student assistant is now stationed in Wiltshire, and is in close touch with those responsible for the scheme and is actively engaged in obtaining accounts suitable for investigational work in this department. The scheme now appears likely to prove very successful. and a considerable addition to the membership is expected.

During the year 63 lectures, exclusive of those given in courses mentioned in the Sectional Reports, have been delivered by Advisers to societies of farmers and fruit growers.

The following Sectional Reports serve to show the nature of the advisory work carried out during the year.

The sections dealing with Agriculture, Agricultural Chemistry, Agricultural Economics, Economic Entomology, EconomicMycology and Willow Culture have been respectively contributed by Dr. J. A. Hanley, Mr. A. W. Ling, Mr. E. P. Weller, Mr. L. N. Staniland, Mr. R. M. Nattrass and Mr. H. P. Hutchinson, the Advisers in those subjects.

Agriculture.

Most of the work on general agricultural questions which comes under the notice of this department is done by the Chief Advisory Officer. Perhaps special attention should be directed to the following points :—

(1) *Grass Land Work.*

A large portion of the time of the staff is taken up with grass land problems. For the third year in succession the Chief Advisory Officer has judged the Herefordshire Pasture Competition, promoted by the Agricultural Education Sub-Committee of that county.

Grassland experiments carried out in conjunction with the Bath and West and Southern Counties Society's Experiments Committee have now been taken over by the Berkeley Square branch and the Advisory Chemist is supervising the field work which includes investigations into the following points :—

(*a*) Manuring of Acid Pastures.
(*b*) Eradication of Bracken.

(2) *Production of Agricultural Lime.*

In conjunction with the Bath and West and Southern Counties Society's Experiments Committee, a survey has been made of the limestones in the Province with a view to the erection of more or less demonstrational plants for producing ground limestone or ground chalk and burnt lime.

(3) *Clean Milk Competitions.*

The Chief Advisory Officer judged the Wiltshire Clean Milk Competition in which there were over 90 competitors. The department was thus brought into close touch with a large number of milk producers in Wiltshire.

(4) *Soil Surveys.*

A good deal of time has been given by the Chief Advisory Officer and Mr. T. Wallace to the Soil Survey of the Lower Lias. Most of this work has been carried out in Worcestershire this year, but opportunity has also been taken of visiting farms from which enquiries on "teart" land have been received, as the "teart" land occurs on the Lower Lias formation.

(5) *Shows.*

Exhibits at Agricultural Shows have in every case been arranged in co-operation with the local County Authorities so that it has been possible to avoid overlapping and to provide one exhibit on agricultural education and research.

CIDER.

The number of enquiries dealt with by correspondence during the year was 261, an increase of 43 on the previous year's figures. They were distributed as follows :—

Gloucester	25
Hereford	16
Somerset	59
Wiltshire	1
Worcester	17
Other areas	143
	261

In addition a large number of visitors called for information concerning cider, and several cider factories were visited during the year. In November, 1925, a cider-making demonstration was given at Long Ashton, at which about 70 visitors were present. Similar demonstrations were given to parties from Devon, Dorset and Wiltshire.

Under the scheme for the provision of local instruction in cider-making demonstrations of cider-making were provided during the autumn at several centres in Monmouthshire and Worcestershire and during the summer of 1926 visits were paid to farmers in Worcestershire (20), Monmouthshire (30), and Dorset (48). During the year also a special course of training was given at Long Ashton to Mr. Pickford, the instructor for the three counties named, and to Mr. Forshaw, who is in charge of the corresponding work in Somerset.

The enquiries received have been very similar in character to those of previous years. Practically the whole field of the subject has been covered. As last year, the planting of new and the renewal of old cider orchards, the problems of the filtration and bottling of cider, storage vessels, and the use of sulphur dioxide for preservative purposes, are probably the subjects of most concern to the industry at the moment.

Included in the above figures are a few enquiries concerned with fruit products other than cider. Most enquiries received under this head are referred to the Campden Research Station for attention and are not included in these statistics. The cases which have been dealt with at Long Ashton have been related in some way to the work of that place.

Pomology.

The number and sources of the pomological enquiries dealt with by correspondence for the year are as follows :—

Gloucester	20
Hereford	3
Somerset	23
Wiltshire	6
Worcester	9
Other areas	54
	115

This figure represents but a small proportion of the actual advisory work on fruit culture now done by the Long Ashton Station. Every year large numbers of visitors call to obtain assistance on their problems, while many advisory visits are paid to growers by members of the Staff.

The predominant subject of enquiry for the year has been strawberry culture. This has undoubtedly been due to the generally unsatisfactory condition of strawberry plantations throughout the country brought about by "red plant" and other pathological troubles. Mr. Ball, the research pomologist of the Station, has given special attention to these problems and during the course of the year has visited many strawberry growing areas in this connection.

The nature of the other enquiries calls for no special comment, the subjects being of an ordinary character.

Agricultural Chemistry.

During the year, 287 requests for advice were received. The sources of these are shown in the following table :—

Gloucester	94
Hereford	35
Somerset	65
Wiltshire	78
Worcester	8
Other areas	7
	287

The materials examined in dealing with these requests for advice and in connection with the County work in the Province include soils, manures, limes, feeding-stuffs and an interesting assortment of miscellaneous substances.

The following samples have been received :—

Soils	239*
Manures	16
Feeding Stuffs	24
Lime and Limestones	27
Dairy Produce	9
Sugar Beet	33
Miscellaneous	15
	363

* Including soils from County Experimental Plots.

In addition to the above, 171 soils were examined in the field for lime deficiency, making a total of 534 samples examined.

The samples placed in the category of miscellaneous include the following :—

Causterising Sludge.
Material from Refuse Destructor.
Sewage Sludge.
Contents of Cows' Stomachs.
Honey.
Tar.
Silo Effluent.

A small paragraph is devoted to those miscellaneous samples with special points of interest attaching to them.

Causterising Sludge. This material is the waste product from Paper Mills in Somerset and contains about 55% calcium carbonate, 7% sodium and potassium chlorides, about 0.6% free water-soluble alkali and 32% moisture.

Material from Refuse Destructor. This material yielded the following figures upon analysis :—

Moisture	6.93%
Ash	89.95%
Total Nitrogen	0.56%
Total Phosphoric Acid (P_2O_5)	3.12%
Potash (as K_2O)	1.60%

It is estimated that this material is worth about 6 - per ton at the farm.

Sewage Sludge. The analysis of this material was as under :—

Moisture	55.30%
Ash	28.15%
Organic Matter	16.56%
Phosphoric Acid (as P_2O_5)	0.49%
Potash (as K_2O)	0.22%
Carbonate of Lime	3.30%
Total Nitrogen	0.93%

Contents of Cows' Stomachs. In the two cases brought to the Advisory Chemists' notice this year it was thought by the farmers concerned that death was due to the cattle having gained access to artificial manures. In the first case, where the cows had been observed to lick bags of mangel manure standing in a field, comparatively large quantities of arsenic were found in the stomach contents, but no trace of poison was found in the manure. The matter was taken up by the County Analyst who was of the same opinion as the Advisory Chemist. In the second case a grass field had been manured with nitrate of soda and the cows were let into the field soon afterwards. In the morning, one cow was found dead, but an examination of the stomach contents and of the manure revealed that death was in all probability due to natural causes.

Tar. The washings from a freshly tarred road ran into a stream bordering a field. Young cattle which were in the field were noticed to lose condition rapidly and become very emaciated soon after the road had been tarred. Eventually, mortality occurred amongst them. The Advisory Chemist visited the place and found that the stream in question was used for drinking purposes by the cattle. It was discovered that the stream, which originally contained fairly large numbers of fish was now devoid of them and it appeared highly probable that the tar washings contained some soluble poisonous substance. At this stage the case was handed over to the Official County Analyst as it was learnt that the farmer had decided to take legal proceedings.

Silo Effluent. A sample of brown liquid, the effluent from a silo, was sent to the laboratory in order to find out whether the

silage was losing much of its feeding value in the liquid draining from it. Analysis revealed that the liquid contained only 0.12% nitrogen.

General Notes on the Soil Samples Examined in the Laboratory.

As in former years, a very large proportion of the soils examined were those from acid areas and where farmers were seeking advice in connection with liming. Quite a number of samples have indicated general starvation of fields and the analytical data have verified subsequent field observations. A good deal of advice has been sought with reference to the sowing down of arable land to grass and the renovation of existing grass. Many of these cases have been dealt with in conjunction with the Chief Advisory Officer.

The Advisory Chemist has paid 100 advisory visits as the result of requests from farmers for advice concerning :—

Manuring.
Liming.
Crop failures.
Feeding and Foodstuffs.
Rat Destruction.
Treatment of grass land.
Treatment of arable land.
Growing of sugar beet.

The majority of these visits have been made in the company of a member of the Agricultural Staff of the County concerned. The closest relationship exists between County Staffs and the Advisory Chemist.

An active part has been taken in the experimental work in the counties, especially in connection with the treatment of grass land and the manuring of sugar beet. A uniform scheme for sugar beet manurial trials was prepared by the Advisory Chemist and this scheme has been adopted by the counties in the Province, and, incidentally, by some outside counties. Arrangements have been made whereby the sugar and dirt estimations will be made this winter at the Bristol centre and a general report prepared as to the results obtained in the Province. It is hoped to be able to publish the information.

Periodical visits have been made to the centres at which liming trials (under the Ministry's scheme) are situated. An excellent result was obtained at the centre in Worcestershire on barley. The experiment at this centre has been in existence for two years. This season, where no lime had been applied, the plot was one

mass of spurrey and no barley was harvested. All the limed plots produced a harvestable crop, the maximum crop being where a dressing of lime equivalent to the determined lime requirement of the soil had been applied. On account of the striking result obtained these plots were visited in June by the Convener of the Liming Committee of the Ministry of Agriculture and Fisheries.

Much of the "Clean Milk" work, formerly undertaken by the Advisory Chemist, was handed over to the Dairy Bacteriologist on his appointment, but some of the farm side of this work has been dealt with by the Chemist.

Soil Testing Outfits. All members of County Staffs have been supplied with soil testing outfits by the Advisory Chemist on somewhat similar lines to the "Soiltex" outfit from America. At present, however, the subject is still in the experimental stages.

Sugar Beet. As the result of a paper read before the Chemistry Committee of the A.E.A., the Advisory Chemist was appointed Convener of a Committee whose terms of reference were primarily to establish a uniform method of sampling and analysing sugar beet. The recommendations of the Committee have been circulated to Agricultural Chemists engaged on sugar beet problems and it is hoped that the results obtained from the various trials throughout the country will be in some measure comparable.

Lime Deposit in Hereford. It was reported last year that an investigation had been started in order to ascertain the economic value of a powdery limestone deposit containing approximately 90% carbonate of lime. It has now been ascertained that this deposit is unfortunately not sufficiently widespread to merit further attention.

Spotting of Sheeps' Livers. A local farmer and butcher brought to the notice of this department a curious case in connection with the spotting of livers of certain of his sheep. It appeared that when the sheep were moved on to certain pastures prior to slaughter their livers were found by the butcher to be spotted. At the intimation of the Ministry of Agriculture and Fisheries, the advice of Mr. N. Bisset, Advisory Veterinary Officer, University College of South Wales, was sought. Mr. Bisset still has this problem under investigation.

Shows. Educational exhibits were prepared for the Three Counties Show at Gloucester, the Somerset County Show at Wells and the Wilts County Show at Chippenham.

Horticultural Chemistry.

Sources of Enquiry.

Gloucester (including Bristol)	10
Hereford	6
Somerset	16
Wiltshire	3
Worcester	6
Other areas	15
	56

Nature of Enquiries.

a) Soil Manurial Enquiries.

Orchard and Fruit Plantation soils	18
Greenhouse soils	3
Market Garden soils	1
Garden soils	6
	28

(b) Miscellaneous Soil Problems.

Soil Conditions causing Chlorosis of Fruit Trees	3
.. .. in cases of Leaf Scorch of Fruit Trees	4
.. .. .. Failure of Fruit Crops	5
.. .. .. ,, Market Garden and Garden Crops	1
,, ,, ,, ,, Greenhouse Crops	3
Suitability of Soils for Fruit growing	3
,, ,, Market Gardening	2
Treatment of "sick" Nursery Soils	1
	22

(c) Miscellaneous Enquiries.

Use of Ground Mineral Phosphates as Manures for Fruit Trees	1
Use of Iodine as a Manure for Fruit Trees	1
Use of Calcium Cyanamide as a Manure for Fruit Trees	1
Manurial Value of Sample of Flue Dust	1
,, ,, ,, Samples of Compound Manures	3
,, ,, ,, Sample of Wood Ashes	1
,, ,, ,, Vegetable Refuse and Grass Cuttings	1
,, ,, ,, Apple Pomace	1
Action of Lime on Meat Manures	1
	11
Number of visits paid in the course of Advisory Work	9

Observations on Enquiries.

The total number of enquiries received was slightly below the number dealt with during the previous year.

The subjects of enquiry were generally similar to those of 1925, relating chiefly to points in connection with the manuring of fruit trees, garden and greenhouse crops, and to failures of fruit and vegetable crops.

The miscellaneous enquiries referred mainly to the manurial values of articles offered as manures for use in fruit plantations and gardens.

Special Investigations in Progress.

1. *Field Experiments on "The Manuring of Fruit Trees, Bush Fruits and Vegetable Crops"* :—

(*a*) Effect of Dung and Potash on Leaf Scorch (Expts. contd.) —in Worcester, Hereford and Somerset.

(*b*) The Effects of Spring and Autumn Dressings of Fertilisers on Apple Trees (Expts. contd.)—in Worcester.

(*c*) The Effects of Artificial Manures on Bush Fruits (Expts. contd.)—in Herefordshire.

(*d*) The Effects of Nitrogenous Fertilisers on Apple Trees under conditions of Low Cultivation—in Herefordshire.

(*e*) The Effects of Artificial Manures on Asparagus—in Worcestershire.

2. *Various Experiments with a view to the Control of Lime-induced Chlorosis in Apple and Plum Trees*—in Worcestershire and Somerset.

3. *Survey of Soils in Fruit and Market Garden Areas on the Lower Lias Formation*—Field and Laboratory work in progress.

Dairy Bacteriology.

The work of the Dairy Bacteriology Department has increased considerably during the past year, 2,391 milk samples having been examined as compared with the 734 samples dealt with during the previous year.

(*a*) *Bacteriological and Chemical Examination of Milk Samples.*

1,623 samples have been examined in connection with :—

(1)	Clean Milk Competitions	1,062
(2)	Farmers holding, or desirous of obtaining, licences for the production of graded milks	203
(3)	Milk Recording Societies	358

(*b*) *Advisory Work.*

During the year 47 visits have been made to farms in connection with various milk problems. These visits, together with requests for advice from farmers, have resulted in the examination of 768 samples from an advisory standpoint. With these are included 191 samples examined in connection with a feeding experiment carried out by the Advisory Chemist and the Agricultural Organiser for Gloucestershire.

The following is a list of problems which have been investigated :—

Tubercular Milk	6 cases
Mastitis	8 ..
Milk Taints	10 ..
Milk of poor keeping quality	1 ..
Cheese-making problems	2 ..

Two of these call for special mention : viz., the cheese-making problem and one case of low " solids not fat." The former has now resolved itself into a question of the buffer salts present in the milk.

The latter problem involved a complete chemical examination of several milk samples. Chemical analyses carried out by the Advisory Chemist revealed a low protein content. The milk appeared normal in every other respect including the magnesium, calcium, phosphate and chloride contents.

(*c*) *Parasitic Disease of Animals.*

In the absence of a Veterinary Officer several diseases of a parasitic nature were referred to the Dairy Bacteriologist. These were dealt with in collaboration with Dr. W. D. Henderson, Department of Zoology, The University, Bristol.

(*d*) *Lectures.*

Two series of lectures on the " Production of Clean Milk " have been given by the Dairy Bacteriologist in connection with Courses for Sanitary Inspectors held in Bristol.

(*e*) *Agricultural Shows.*

The Dairy Bacteriologist has been responsible for exhibits at the County Shows dealing with the production of " Clean Milk " and the examination of milk samples.

Economic Entomology.

The number of letters of enquiry dealt with during the year was 177, distributed among the Counties as follows :—

Gloucester	35
Hereford	14
Somerset	32
Wiltshire	10
Worcester	26
Other counties	60
Total ..	177
Number of Farms visited	94

The number of enquiries shows an increase of 6 when compared with last year. Very few enquiries were received from the County

Officers. Enquiries from other Counties were dealt with as stated in the report on Economic Entomology last year. Much information has been given to growers on their own plantations and farms, and numerous enquiries of visitors to the Research Station plantations have been answered.

The most serious pests of the year were as follows :—

Capsid Bugs (*Plesiocoris rugicollis*). *Plesiocoris rugicollis* has again been widespread throughout the Evesham, Pershore and Cheltenham districts and in the County of Hereford. Capsids also did considerable damage to raspberry canes in the Cheltenham district. Thus the situation throughout the Province is similar to that of last year. It would appear that the bugs continue to spread to other areas.

Codling Moth (*Cydia pomonella*). Damage to apples by this pest has again been serious, especially that caused by the attacks of the second brood. Many growers who sprayed their trees with Lead Arsenate as soon as the petals had fallen suffered badly, in spite of this treatment, from the second brood. The prolonged flowering period probably accounted for this as it was difficult for growers to spray more than a portion of the tree at the proper time.

Ground Beetles (*Harpalus ruficornis*). This beetle, by eating the surface of strawberries, did very considerable damage to fruits at Cheddar. From 70-80 per cent. of the crop was damaged in some beds. The attacks often started near a hedgerow and spread across the plots. The damage was further accentuated by fairly bad attacks of slugs.

Strawberry Aphis (*Capitophorus fragariae*). This aphis has been a serious pest and of general occurrence throughout the Province. The varieties of strawberries which suffered most from its ravages (in order of susceptibility), were Madame Kooi, Laxtonian, Royal Sovereign, Paxton, Stirling Castle and President. Observations indicate that the varieties Tardive de Leopold, Lord Overton, Sturton Cross and Aberdeen Standard appear to be resistant to attacks of Strawberry Aphis. Reference is made later to special investigations on this pest.

Pear Midge (*Contarinia pyrivora*). This pest continued to increase. An account is given later of the work which has been carried out to date in the field during the season.

Black Currant Aphis (*Capitophorus ribis*). Where growers did not spray with an efficient tar-distillate wash during the dormant period, infestations of this aphis were widespread and very heavy.

Woolly Aphis (*Eriosoma lanigera*). Infestations by this aphis have increased as compared with those of last year.

Rosy Apple Aphis (*Anuraphis roseus*). This aphis, which has caused serious damage throughout the Province, was much more severe than it has been for two years.

Cherry Fruit Moth (*Argyresthia ephipella*). Enquiries concerning Cherry Fruit Moth have been received from the Evesham district, where the pest seems to be increasing. Though tar-distillate washes appear to have exercised some control over the pests, experiments are necessary to determine more exactly the effects of such washes on this insect.

Approximately one third of the enquiries received referred to the following subjects :—

Sprays.	Tar-distillate washes for winter use. Oil sprays for spring and summer use.
Pests.	Strawberry Aphis. Capsid Bugs.

The remainder of the enquiries referred principally to the following :—

(*a*) Pests with reference to Specific Plants.

Host Plant.	Pests.
Apple	Apple Sawfly (*Hoplocampa testudinea*)
,, ...	Winter Moth (*Cheimatobia brumata*)
,, ...	Permanent Apple Aphis (*Aphis pomi*)
,, ...	Apple Blossom Weevil (*Anthonomus pomorum*)
,, ...	March Moth (*Anisopteryx aesculi*)
,, ...	Feathered Thorn Moth (*Himera pennaria*)
,, ...	Peppered Moth (*Pachys betularia*)
,, ...	Leaf-eating Weevils (*Phyllobius oblongus*)
,, ...	Leopard Moth (*Zeuzera pyrina*)
,, ...	Mussel Scale (*Lepidosaphes ulmi*)
Apple and Black Currant ..	Capsid Bugs (*Plesiocoris rugicollis and Lygus*)
Plum	Mealy Plum Aphis (*Hyalopterus pruni*)
,, ...	Leaf-curling Plum Aphis (*Anuraphis prunina*)
Black Currant ..	Big Bud (*Eriophyes ribis*) and Reversion disease.
,, ,, ..	Capsid Eggs.
Pear	Pear Leaf Blister Mite (*Eriophyes pyri*)
Ash	Sawfly larvae
Gooseberry	Gooseberry Aphis (*Aphis grossulariae*)
,, ..	Gooseberry Sawfly (*Nematus ribesii*)
Asparagus	Asparagus Beetle (*Crioceris asparagi*)
Chrysanthemum ..	Chrysanthemum Aphis (*Macrosiphoniella sanborni*)
Various Brassicae ..	Cabbage Gall Weevil (*Ceuthorrhynchus sulcicollis*)
Clover	Clover Weevil (*Sitones lineatus*)
Potato	Slugs
Willow	Willow Aphis (*Cavariella capreae*)
Carnation	Caterpillars (*Tortrix pronubana*)
Aster	Cutworms (*Agriotis spp.*)
Mushroom	*Sciara sp.*

(*b*) Miscellaneous.

House Mite (*Glyciphagus sp*).
Lime and Privet Hawk Moths.
The Large Red Ichneumon (*Ophion luteus*).
Arsenate Sprays, combination sprays, lime-sulphur sprays.
Spraying soaps, nicotine sprays, casein spreaders and colloidal sulphur.
Cyanide fumigation.
Spraying machines.
The effect of orchard sprays on poultry running beneath the trees.
Arsenic on apples.
Insecticide dusts.
Fleas in a pig-sty.
Ointment for use against Warble flies.
Leather-Jackets damaging lawns.
Dipping of strawberry runners.
Poison baits for slugs.
Soil fumigants.
Grease banding.
Bird damage to filberts and cobs.

Field Investigations and Trials Carried out in the Counties.

Capsid Bug (*Plesiocoris rugicollis*).

During the year spraying trials have been carried out in the Bristol Province against *Plesiocoris rugicollis*.

Experiments.

A. On Apples.

I. Use of a tar-distillate wash at 10 per cent. strength, applied in winter as an egg-killing wash. The brand found to be most effective in 1924-25 was used. These experiments were carried out in Gloucester, Worcester and Hereford.

II. Use of an Oil Spray against the bugs in the spring.

B. On Black Currants.

I. A tar-distillate wash as used for the experiments on apples. These experiments were carried out in Worcester and Hereford.

The results of these experiments are as follows :—

A. I. Experiments with a tar-distillate wash at 10 per cent. strength on apples.

The experiments have confirmed the results obtained last year, which were that a good control of capsid bugs can be effected by certain tar-distillate washes, used as egg-killing washes, at 10 per cent. strength. The obtaining of such a control by such sprays is not certain, presumably because certain weather conditions following the spraying operation appear to render the spray relatively innocuous.

II. Use of an oil spray against the bugs, in the spring, on apples.

The experiments were designed to test further a proprietary oil spray as a spring spray against capsid bugs. It was found impossible to carry them through because the consignment of oil spray supplied for the purpose was faulty and could not be emulsified satisfactorily. Damage resulted in those instances where it was applied. Samples of this proprietary oil were used with success in last season's experiments.

B. I. Experiments with a tar-distillate wash at 10 per cent. strength on black currants.

The experiment in Hereford yielded no results, the pest not being present on the controls, in spite of a severe attack the previous year.

The experiment in Worcester had one feature of particular interest. A plantation of apples, interplanted with black currants was sprayed. The spray fluid used was identical in both cases and the trees and bushes were treated on the same occasion.

The tar-distillate washes exercised little control over Capsid eggs on black currants, while effecting a good control of the eggs in the case of the apples.

Tar-Distillate Washes for Winter Use.

Experiments with these washes were distributed among the counties as follows :—

Gloucester	2
Somerset	1
Wiltshire	2
Worcester	2

The trials were in continuation of last year's experiments with the washes as a control for aphis, apple sucker and caterpillars on apples, and aphis and caterpillars on plums. The two brands of these washes found to be most effective in the past seasons' experiments have been used for these further trials in collaboration with the Research Entomologist and the County Officers. The planning and supervision of the individual trials were carried out by the writer. The results were examined both by the Research Entomologist and by the writer, with the help of the County Officers, in some instances. A full account of these results will appear elsewhere.

Pear Midge (*Contarinia pyrivora*). A preliminary experiment was carried out in collaboration with the Research Entomologist

in the Evesham district of Worcestershire on the use of essential oils and other substances as possible attractants for Pear Midge. The substances were mixed with banding grease and exposed on boards hung in the trees. Out of the sixteen possible attractants tested, oil of bitter fennel, clove oil and nitro-benzene (oil of mirbane) proved to be of sufficient promise to justify further experiments next year. In addition to these it is proposed to test other possible methods of controlling the pest in 1927.

Strawberry Aphis (*Capitophorus fragariae*). Field work in connection with Strawberry Aphis has taken chiefly the form of observation work in order to obtain information as to the distribution of this pest and the extent to which it is responsible for the troubles which strawberry growers are experiencing. A considerable number of visits have been made in connection with this work.

Willow Aphis (*Cavariella capreae*). A trial was carried out in the principal willow-growing district of Somerset, which had as its objects the testing of a new and improved method for the spraying of willows and the further testing of rape oil emulsion at $\frac{1}{2}$ per cent. strength as a control for Willow Aphis. Similar experiments were carried out on the willow plots at Long Ashton. The work carried out last year, and referred to in last year's report, remains ready for publication.

Hop Aphis (*Phorodon humuli*). A trial was carried out in Hereford against this pest. The sprays used were two oil sprays, one of which was a proprietary one.

The oil in each case was used at a strength of 1 in 200 (*i.e.*, $\frac{1}{2}$ per cent.), as it had been found in previous trials that no damage resulted from such treatment. The non-proprietary oil spray was crude rape oil. The method of mixing is referred to in the section of this report dealing with work on oil sprays. In each case the oil spray, when finally prepared, had 1 per cent. of "free" soap present in order to ensure that thorough wetting took place. The water was of medium hardness.

The sprays were applied to two rows of hops, each containing some fifty hills. The remainder of the garden, which was considered an ample control, was not sprayed. The sprays were applied with an ordinary hand-pumped tank sprayer, giving a pressure of from 50-60lbs. to the square inch. A medium-fine nozzle was used, as it has been found that a coarse nozzle is not so effective for the application of oil sprays. The date of application of the sprays was June 29th, 1926. The day was fine and very hot, with little wind.

The bines were examined on June 30th, 1926, when it was found that no damage to the bines had resulted, nor did any appear at any future date. The kill was very satisfactory, and in the case of both sprays, was practically 100 per cent.

The costs of these oil sprays compare very favourably with a nicotine wash used at a strength of 5 ozs. to 100 gallons, where the amount of soap required is the same as for the oil sprays, the costs of the former being approximately half the cost of the latter.

It is hoped that during the coming season it may be possible to carry out trials which will furnish figures necessary to compare the efficiency and costs of dusting and wet spraying with oil sprays at low strengths.

Red Spider (*Tetranychus altheae*) on Hops.

(*a*) *Trials with Oil Sprays.*

It was thought possible that oil sprays might furnish an efficient control for Red Spider on hops and, with this end in view, arrangements for an experiment were made in Herefordshire.

As a preliminary trial a number of male bines were sprayed with oil sprays of different strengths. Sulphur compounds were added to some of the sprays.

Details of treatment and results are summarised in the following table :—

NUMBER OF STOCKS SPRAYED.	SPRAY.	EFFECT.
10	1% Rape Oil Emulsion.	No scorching.
5	1% Rape Oil Emulsion with Sodium Polysulphide at rate of 1 in 80.	Scorched.
5	1% Rape Oil Emulsion with Ammonium Polysulphide at rate of 1 in 200	Badly scorched.
10	2% Rape Oil Emulsion.	Slightly scorched.
2	5% Rape Oil Emulsion.	Very badly scorched.

The sprays were applied on May 21st, 1926, and examined a fortnight later. Where stocks were scorched they grew away from the damage, but the leaves and embryo laterals to which the spray was actually applied were spoilt. From the results presented in the above table it will be seen, therefore, that 1 per cent. or less, was a safe strength at which to apply rape oil emulsion to hops, but the addition of sulphur compounds to the 1 per cent. emulsion produced scorching.

Preparations were made to test 1 per cent and ½ per cent. rape oil emulsion on a larger scale against Red Spider. The pest, however, did not appear in sufficient numbers and the spraying was not continued. It is proposed to attempt to carry out the experiment in its entirety next season.

(*b*) *Trial with Calcium Cyanide.*

To test the effect of calcium cyanide, fifty hills were treated with it at the rate of 2ozs. per hill on March 24th, 1926. The cyanide was scattered by hand and immediately scuffled in.

The treatment aimed at the control of the Red Spider in the soil before its migration upwards.

As stated above, Red Spider did not appear in sufficient numbers to obtain a result. No damage to the stocks resulted.

Woolly Aphis (*Eriosoma lanigera*). A preliminary trial of the use of para-di-chlorbenzene as a soil fumigant against the root form of Woolly Aphis, was carried out in Hereford in collaboration with Mr. J. F. Goaman, Ministry of Agriculture.

The experiment showed that a good control was exercised by the fumigant, without injury to the tree. The results are sufficiently promising to warrant a continuation of the work.

A cheap and effective control of the root form of this pest would seem to be possible by the use of para-di-chlorbenzene.

Field and Laboratory Work at Long Ashton.

Strawberry Aphis (*Capitophorus fragariae*). During the last season work on this pest has been carried out and the effects of strawberry aphis on the strawberry plant have been investigated. This work will be published shortly in the Journal of Pomology.

Work on this pest, with special regard to control measures, will be continued during the coming season.

Recently, a new disease of the strawberry has been described in California.* The disease is known there as "Strawberry Yellows" and, as far as can be seen from the account and illustrations given, the symptoms are identical with those described in the paper referred to above. The disease is now accepted, in California, as being caused by a virus, probably carried by insects. An aphis (*Myzus fragaefolii*), is thought to be the principal vector. The view of the writer of this report is that the present available evidence obtained during the season's work does not justify such symptoms being attributed to virus action in any of the many

* Plakidas, A.G. :—"'Strawberry Yellows.' A Degeneration Disease of the Strawberry."
Phytopathology—Vol. 16; No. 6.

cases examined by him, or in the experiments which have been carried out. This aspect of the problem will receive special attention next year. Some of the evidence against the theory of virus action will be found in the work to be published shortly in the Journal of Pomology.

Black Currant Aphis (Capitophorus ribis) as a Vector of Reversion Disease.

Cross infection experiments to test the possibility of *Capitophorus ribis* being a vector of Reversion Disease are being carried out by the Research Entomologist. The writer of this report suggested that the study of the method of feeding and the source of the food-supply of this aphis might be expected to furnish information likely to be of use in the investigation, for which reason the source of the food supply and the method of feeding have been worked out in the case of the apterous viviparous female. Similar information will be obtained in respect of the winged forms of the aphis next season.

Strawberry Eelworm (Aphelenchus fragariae). The work on the hot water treatment of runners has been completed. It was found impossible to obtain a temperature and time for treatment which would give a 100 per cent. control of the eelworm without injury to the plant. Interesting results, however, were obtained with regard to the effect of the partial or complete killing of the roots on the type of foliage produced. These results are of interest when considered in relation to various types of disease present in the strawberry and particularly in connection with Strawberry Aphis and Strawberry Eelworm. It is hoped to refer to these results in some future paper.

A Cecidomyid Fly Associated with Damaged Worked Buds on Apple and Plum.

During the last "budding" season at Long Ashton a high percentage of the failures were associated with the larvae of a Cecidomyid fly. The larvae were found under the bark of the stock, apparently causing the death of the cambial tissues. In some cases the larvae were found under the bud. The presence of the larvae was in all cases associated with the failure of the bud to "take," the bud being in a dead or dying condition.

A common mould was present in all cases wherever larvae were found. As far as could be seen the larvae appeared to be primarily responsible.

Methods of control have been devised and tested during the season with the assistance of Mr. E. Umpleby, Propagator and

Assistant Recorder at this Station. The buds were painted with the following immediately after tying :—

(*a*) Vaseline.
(*b*) Lead Arsenate.
(*c*) Cocoanut Oil.
(*d*) Palm Oil.
(*e*) Cocoanut Oil containing 1 per cent. of Phenol.

Buds untreated were left as controls. The vaseline treatment shows great promise of being entirely successful, no damage to the bud taking place. The treatment appears to prevent the appearance of the fungus as well as the larvae of the fly, but a further season's trial on a larger scale is necessary before any recommendations can be made.

Agricultural Shows.

Exhibits were staged and attendance made at the following Agricultural Shows :—

Three Counties Show, Gloucester.
Wilts County Show, Chippenham.
Somerset County Show, Wells.
Imperial Fruit Show, London.

Economic Mycology.

Numbers of Enquiries. R.M. NATTRASS,

The total number of enquiries dealt with by post during the year was 182.

Sources of Enquiries.

Gloucester	53
Hereford	16
Somerset	37
Wiltshire	17
Worcestershire	35
Other Counties	24
	182

Visits.

Visits paid to farmers and growers, 130.

General Observations on Enquiries.

The number of enquiries shows an increase on last year of 66. The majority of the enquiries were from fruit growers, market gardeners, nurserymen and private gardeners. It is noticeable that only 18 enquiries were received from the five county authorities, of which 11 were received from the Gloucestershire County Agricultural Authority.

During the present year the exceptional weather conditions have been reflected in the serious outbreak of many fungus diseases. The very prevalent occurrence of " Brown Rot " of fruits may be

attributable in part to the splitting of the skin of apples and plums, brought about by the weather conditions which prevailed. Briefly reviewed, these conditions consisted of a prolonged cold spring, lasting up to the end of June, followed by a spell of warm summer weather. This soon broke to warm damp conditions, lasting till the end of September.

Observations on the more important diseases are as follows :—

(1) *American Gooseberry Mildew.* An exceptionally early outbreak was reported from the Evesham district on March 15th, the variety attacked being "Whinham's Industry." The disease frequently appeared to have obtained a hold before the setting of the flowers. Losses due to this disease have been very heavy and a cheap and efficient control is urgently needed. Owing to the ravages of the disease many growers are giving up the cultivation of the variety "Whinham's Industry," on account of its susceptibility to the Mildew.

(2) *Apple Mildew.* This year has seen what is probably one of the worst attacks of apple mildew in the Province within recent years. The more severely attacked varieties were Bramley's Seedling, Bismarck, Allington Pippin and Cox's Orange Pippin.

(3) *Apple and Pear Scab.* This disease has again been serious and particularly severe losses have been experienced on commercial plantations of Worcester Pearmain.

(4) *Fruit Rots.* Partly owing to the exceptional weather conditions mentioned above, a large amount of fruit cracking occurred among apples and plums. As would be expected, during the warm damp weather, a severe attack of Brown Rot (*Monilia fructigena*) broke out. From all parts of the Province reports were received of fruit being affected while still on the trees, whilst fruit drop due to this fungus was very considerable. A large proportion of the fruit sent in for examination was found to be infected with *Monilia fructigena.* The "black rot" form was frequently present.

In addition to the common fruit rot, *Monilia fructigena*, a number of cases have been observed of an "eye rot" of apples—the causal organism of which is thought to be *Nectria galligena.* The disease, which occurs commonly on the variety Worcester Pearmain, is manifested by a sinking in of the flesh in the region of the eye. The skin in the infected area is discoloured a light brown. Large numbers of small whitish pustules, bearing conidia, which do not differ morphologically from those of *Nectria galligena*, are formed on the surface of the affected area. Though the perfect stage of the fungus has not yet been formed in pure culture there seems

to be little doubt that the causal organism is *Nectria galligena*. Ripe perethecia of this fungus have been found on mummied apples by Mr. Dillon-Weston.

An eye rot of pears was observed in a perry orchard in Gloucestershire. In this case the rot attacked half ripe pears while on the tree. Though no sporodochia were formed on the fruit a fungus identical with *Nectria galligena* was isolated from the diseased tissue.

In 1925, a considerable amount of work was done on a rot of pears similar to the one described above on apples by Dr. Briton-Jones and the writer. It seems probable that the 1925 rot of pears is identical with that found in 1926 on apples. Parallel culture and cross inoculation work is now in progress to establish the exact identities of these organisms. It would appear that under certain conditions this disease may become a serious menace. As far as the adviser is aware, no instance of a rot of this nature was recorded in the Bristol Province until 1925, when a single case referred to above was brought in by Mr. A. H. Lees.

A " Black Rot " of Worcester Pearmain apples has also been received from Herefordshire. It was observed by the grower on the fruit during packing. In this rot the skin of the apple in the affected area becomes quite black and dotted over with numbers of minute immature picnidia. Though affected apples have been kept many weeks these fruit bodies have not reached maturity. The flesh of the apple becomes black and spongy, but there is very little drying out of the tissue until the final stage is reached. The mycelium permeating the flesh is coarse dark olive green and contains innumerable oil globules. Isolations and inoculations into living apples and apple twigs have proved the pathogenicity of the organism. Its identity, however, cannot be established until mature fruit bodies are formed. It was suggested that the fungus might be *Physalospora cydoniae* (*Sphaeropsis malorum*) which is known to cause a black rot of apples in America. A culture of this latter fungus was obtained from the Pure Culture Station at Baarn. Parallel cultures and inoculations showed that these two fungi were not identical.

An unusual form of the *Phytophthora Rot* of pears has been observed. When first examined only the skin of the fruit was discoloured, the flesh below being quite firm and white. Minute flecks of discoloured vascular tissue occurred in the flesh of the pears. In addition to these the endocarp was also discoloured brown. The fungus was isolated from the skin and also from the vascular tissue in the healthy flesh. Superficially it has all the appearance of a physiological disease until pustules of sporangiophores burst through the skin. The name " Hard Rot " given by the grower is appropriate.

(5) *Bud Rot of Apples.* A bud rot occurring on the variety Bramley's Seedling has been noticed in Somersetshire. In this disease, the inflorescence buds are attacked some time before they are due to open. These diseased buds fall off at a touch, the diseased tissues apparently being cut off by a cork-layer. The stopping of the truss causes an adventitious bud at the base to break, producing a short shoot. In a bad case up to 30% of the buds were affected. A fungus has been isolated from diseased buds, but it has not yet been possible to carry out any inoculation experiments. Severely affected trees were those which appeared to be in a "nitrogenous" condition, growing in humid sheltered situations. The organism isolated and the general appearance of the disease is distinct from that of the familiar *Fusarium* Bud Rot of apples.

(6) *Rusts.* An early and extraordinarily severe attack of the common plum rust (*Puccinia pruni-spinosae*) occurred in the Province. In some cases complete premature defoliation of the trees took place. It was observed that while Victorias were most severely attacked, Monarchs showed a fair degree of resistance. In one plantation the attack was observed to start on the trees which were growing in close proximity to a bed of anemonies.

Severe attacks of "rusts" have occurred on many host plants, both economic and otherwise. Heavy attacks have been reported on rye grass and cocksfoot, impairing the feeding qualities of the pastures. The attacks appear to be more severe on temporary leys than on old permanent grass. This may be due to non-indigenous seed, grown in drier parts of the country, being more susceptible when grown in the moister Western Counties.

(7) *Raspberry Diseases.* Few cases of "raspberry die back" have been observed during the period under review and no fresh outbreaks of *Nectria rubi* have come to the adviser's notice.

In one particular case of "Die Back" and "Crown Rot," in the variety Lloyd George, white pustules were to be seen bursting through the bark at the base of the canes. These pustules proved to be the sporodochia of a species of *Fusarium*, bearing hyaline 2-3 septate spores measuring 37μ. by 5μ. These spores are slightly attenuated at one extremity. They correspond in size and shape to those of a species of *Fusarium* described by Wormald* on the crowns of diseased raspberry canes. The fungus has been isolated and grown in pure culture. Morphologically and in

* Wormald.—Wilting of Raspberry and Loganberry Canes. Journal of S.E.A. College, Wye. No. 22, 1913.

cultural characteristics it bears no resemblance to the conidial stage of *Nectria rubi*.

The "anthracnose" of Raspberries (*Gleosporium venetum*), has done a considerable amount of damage on certain varieties, notably "Baumforth."

The Mosaic disease of Raspberries is very widespread in the Province and there seems little doubt that much of the falling-off in yield and susceptibility to other diseases is due in part to this insidious trouble. Few growers seem to recognise in it a pathological symptom and hence they have no hesitation in propagating from diseased stools.

(8) *The White Root Rot* (*Rosellinia necatrix*). This fungus, which has previously been recorded as causing a root rot of apples in this Province, has been found attacking and causing a root and tuber rot of potatoes.

(9) *Rhizoctonia solani*. A case of this fungus attacking the roots in addition to the tubers of potatoes was received from Herefordshire.

(10) *Rhubarb Crown Rot*. An outbreak of the Rhubarb Crown Rot has occurred in the Pershore district, probably through the importation of infected sets from the North of England.

(11) *Die Back of Apples* (*Monilia cinerea*). An interesting case of Die Back of apple twigs was observed in Worcestershire. The symptoms were similar to those observed in Somerset in 1925, to which reference was made.† In early summer the foliage on the diseased current year's wood is withered for a distance of up to two feet from the tip. At the base of this dead portion a canker occurs. There is no sinking in of the tissue as in the case of a canker caused by *Nectria galligena*. Infection appears to take place through a bud or spur from which centre a series of fine black wavy lines radiate. From these cankers the fungus *Monilia cinerea* was isolated. Such withered twigs, which may number up to 15% of the whole, stand out in strong contrast against the healthy foliage.

(12) *Foot Rot of Wheat*. Serious loss has been brought about this year by the "foot rot" of wheat. It has been particularly noticeable in the large corn growing districts in Wiltshire. Examined casually, the crop appears to be normal, but disappointing yields are obtained when the corn is threshed out, a large proportion being classed as "chicken corn." *Ophiobolus cariceti* is the chief organism responsible.

† Report of Adviser in Mycology—Station Report, 1925.

(13) *A Canker of "Head Worked" Trees.* A disease of trees that have been cut back and head-worked has been observed in parts of Herefordshire. The disease takes the form of a shallow canker on the old wood just below the graft. It only occurs on those branches which have had the "feather" removed. The presence of this feather, doubtless by keeping up the flow of sap, makes the wood resist fungal attack.

Growing on the surface of the canker are a number of small olive-green picnidia containing oval hyaline conidia, 10-14μ. by 7-8μ. This fungus has been identified by Miss Wakefield as *Fuckelia conspicua Marchal.* It has not been recorded hitherto as forming a canker on apples. Since it is probable that large numbers of trees will be headed back in the future the disease described above may become serious and growers are advised not to remove any of the young woody shoots until the grafts are well established.

(14) Willow Diseases.

During the period under review a number of willow diseases have been brought to the adviser's notice by Mr. H. P. Hutchinson, the Willow Research Officer.

In addition to the fungus *Melampsora* on leaf and rods, which causes serious damage to willows in Somerset, the following fungi have been observed :—

1. *Physalospora sp.* This disease has always been present to a greater or less extent in the Somerset willow districts, forming large cankers on the rods.

This year, however, a serious form has been observed on the Long Ashton willow beds. The one year shoots and wood have been most seriously affected. The fungus appears to start as a diseased patch on a leaf, travels down the midrib and petiole to the stem, where a canker is formed. A "die back" may be caused from the tip of the youngest shoots. So severe has been the attack in some cases, that certain stools have produced nothing but shoots 12-18 inches in length instead of the fully grown rods.

2. *Black Canker* (*Unidentified*). From time to time cankers have been examined from which a fungus has been isolated which is quite different from *Physalospora sp.* mentioned above. Inoculations show that this fungus is pathogenic and capable of producing cankers.

3. *Anthracnose.* An Anthracnose has been observed on rods of the variety "Red Welsh." In the centre of each spot occur acervuli bearing curved uniseptate conidia, averaging 12.25μ-17.5μ by 5.25μ-6μ, with lower cell much smaller than the upper.

Morphologically this fungus agrees fairly closely with *Marssonina salicicola, Bresed.*

A number of diseased rods were planted further to study the disease but, unfortunately, these were destroyed by fire.

4. *General.* From cankers on willow rods the fructifications of the following have been found :—

(*a*) Cytospora sp.
(*b*) Hendersonia sp. identical with H. rubi.
(*c*) Coniothrydium sp. ,, ,, C. fuckellii.

The latter fungus, Coniothrydium, was isolated and inoculations made showed that it was capable of forming a canker, but that the cankered portion was quickly cut off by a cambial layer.

Special Investigations Carried out in 1925-26.

(1) *Brown Rot Spraying Trial.* A spraying trial was carried out in Gloucestershire on the control of " wither tip " and " brown rot " of plums (caused by *Monilia cinerea*).

The trial plot consisted of 108 Victoria plum trees, 12 years old. Two control belts of 24 trees were left unsprayed. During 1924 the trees had been badly affected with the " wither tip " disease.

The trees were sprayed in mid-January with 6% Mortegg. The plot was examined in May. Though only a few fresh infections of *Monilia cinerea* were to be seen on the control trees on this occasion, the sprayed trees were very much cleaner. The amount of " wither tip " on the control trees was not sufficiently great to permit of a numerical comparison with that on the sprayed trees. The effect of the spraying was also somewhat masked by the almost complete control of plum aphis.

(2) *American Gooseberry Mildew Spraying Trials.* Spraying trials for the control of American Gooseberry Mildew were again carried out at Cheltenham.

A full account of these trials is given elsewhere.

(3) *White Rot of Onions: Immunity Trials.* A further trial on the immunity of varieties of onion to the White Root Rot disease (*Sclerotium cepivorum*) was carried on in collaboration with Mr. E. Holmes-Smith, Adviser in Agricultural Botany, Manchester University.

(4) *Apple Scab Spraying Trial.* A large scale trial on the control of Apple Scab was planned in collaboration with the Agricultural Organiser for Worcestershire. Some 350 trees of the variety Worcester Pearmain received two applications of an Excess Lime Bordeaux Mixture, made to the 8-25-100 formula.

The first application was given on April 14th, the trees then being in the " pink bud " stage. The second application was given on May 20th.

Although an excellent control of the Black Scab fungus was obtained, cracking of the fruit took place on the sprayed trees to such an extent that much of the fruit was useless. The reasons for this result are not clear; Bordeaux Mixture, made to the above formula, has been used in previous years on Worcesters without damage. Although fruit on the Control trees was not cracked, much similar cracking occurred elsewhere on unsprayed trees. The peculiar weather conditions are thought to be chiefly responsible.

(5) *Experiments on the Use of Oil Sprays in Controlling Scab.* A preliminary experiment was carried out in collaboration with Mr. L. N. Staniland on the use of certain oil sprays as fungicides.

1. A copper soap dissolved in rape oil and subsequently emulsified.
2. The application of a rape oil emulsion as a cover spray after an application of Bordeaux Mixture.

The results obtained warrant a further trial next year.

(6) *Raspberry Diseases.* Further experimental work has been carried out on the pathogenicity of the fungus *Nectria rubi.*

Twenty-five plants each of the varieties Worcester Prolific, Red Antwerp and Bath's Perfection were potted up in ten inch pots in the autumn of 1925. These were inoculated in February two inches below soil level by placing the inoculum in a cut in the " crown."

The following inocula were used :—

1. Agar plates of ascospores from mature perethecia found in nature were poured. In eight days separate individuals were about 4mm. in diameter and sporing abundantly.

   A separate individual was used for each inoculation.

2. One mature perethecium crushed and placed in the wound.
3. A small wedge of raspberry root culture bearing mycelium and conidia.

One series of ten pots was treated with an overdose of ammonium sulphate to check the plant, and another series was placed in a trough containing six inches of water to simulate severe water-logging conditions.

In no case up to the present has a definite "take" of *Nectria rubi* resulted.

It is interesting to record that in the waterlogged specimens the pathological symptoms of marginal leaf scorch and small leaf were produced. Examination of the waterlogged specimens also showed a purple discolouration of the roots which frequently occurs in plants suffering from "Die Back" in the field. From these roots a *Coniothryium* was isolated. The conditions under which *Nectria rubi* may become pathogenic, if at all, have yet to be determined.

(7) *Asparagus Diseases.* Several asparagus beds in the Evesham district were visited by the Adviser during the year in the investigation of the Asparagus Soil Sickness problem. It is generally accepted that the causal organism is the fungus *Rhizoctonia crocorum*, though it is by no means proved that this is the only parasite. Mr. G. C. Maltby has found perithecia of *Zopfia rhizophila* (Rabenh) on diseased roots and the writer has isolated an undetermined *Fusarium* from brown discoloured patches on otherwise healthy roots. This latter fungus strongly suggests a root parasite. In culture the spores are slightly curved 3-4 septate and measure 35μ-52μ from point to point and 3μ-4μ in width. Inoculations to test the pathogenicity of this fungus are being carried out.

In order to carry out preliminary tests on soil treatment a supply of soil from two badly affected plots of land in the Evesham district was obtained and potted up in large ten inch pots. It being considered desirable to demonstrate the presence of *Rhizoctonia crocorum* in the soil before attempting any kind of soil treatment, these pots were all sown with carrots. Previous experiments had shown that *R. crocorum* readily infects carrots. These carrots will be harvested and examined in the autumn.

In connection with the Control of soil fungi a visit was paid to the Lea Valley Research Station at Cheshunt. Much information and advice was given by Dr. Bewley and his staff.

Since "Soil Sickness" of asparagus land is undoubtedly due to soil dwelling fungal parasites, the problem can be approached in at least two ways

(*a*) by soil treatment,

(*b*) by genetics.

It is doubtful if a cheap and efficient soil steriliser will be produced which can be used on a field scale. It seems that the problem will ultimately be solved by the evolution of resistant varieties.

With this end in view an experimental asparagus plot has been started at the Research Station, Long Ashton. This has been planted up with well known commercial varieties, free from disease and true to name. This plot will be of great value for future work on the resistance and susceptibility of varieties to root diseases.

(8) *Investigations on Willow Diseases.* Work has been done on the life history of the Willow Canker Fungus—*Physalospora sp.*

A detailed study has been made of the species of *Physalospora* responsible and its connection with a *Gleosporium* conidial stage has been proved by cultural work. Inoculation experiments have shown that both ascospores and conidia can infect leaves and growing points without the intervention of wounds.

The fungus, which has been proved to be a virulent parasite, directly infecting leaves and succulent tissus, is regarded as being not essentially different from *Physalospora miyabeana*, Fukushi.

Physalospora gregaria, Sacc., has not been seen by the adviser on any of the willow material examined by him.

Monospore cultures have been made from ascospores and conidiospores. In both types of culture mature perethecia have been produced.

(9) *Trial of Immunity of Swiss Varieties of Potatoes to the Late Blight* (*Phytophthora infestans*). At the request of the Ministry of Agriculture certain Swiss varieties of potatoes said to be immune to the Late Blight (*Phytophthora infestans*) were grown at Long Ashton.

Two pounds of seed of eleven varieties were grown. These were interplanted with rows of the variety King Edward.

Observations on the incidence of the disease and crop weights were obtained.

The King Edward row to the extreme west was artificially infected with the late Blight Fungus at the beginning of August. On August 11th a small amount of the disease was noticed on the variety "Welt wunder."

Observations were made on August 27th, by which time the King Edwards were severely attacked on the foliage.

The varieties were divided into three classes :—

1. *Resistant.*
   Vor der Front.
   Vaterheim.
   Nogi.
   Prof. Wohlmann.

2. *Fairly Resistant.*
   Aspasia.
3. *Not Resistant.*
   Blochinger.
   Weltwunder.
   Bauerngluck.
   Atlanta.

Investigations to be Continued.

Many of the investigations referred to in the foregoing section are only in their initial stages. Work on these will be continued—more attention particularly being paid to the following :—

(1) *Die Back of Stone Fruits.* Observations will be made from time to time on the rate of progress of the inoculations of *Diaporthe perniciosa.* Further information of the " Die Back " disease will be gathered from field observations.

(2) *Control of Bunt in Wheat.* Trials of wheat treated with different fungicides for the control of " Bunt " have been arranged at four centres in the Province.

(3) *American Gooseberry Mildew.* A further series of trials on the control of American Gooseberry Mildew will be carried out during the coming season.

(4) *Asparagus Disease.* The investigation of " Soil Sickness " of Asparagus land in the Evesham district will be continued.

(5) *General.* In addition to the above main problems a number of investigations of minor importance are being continued as time and opportunity permits.

General.

Shows.

An exhibit illustrating fungus diseases of agricultural and horticultural crops was shown and demonstrated at the following Shows :—

1. Somerset County Show at Wells.
2. Wiltshire County Show at Chippenham.
3. The Three Counties Show at Gloucester.
4. Imperial Fruit Show at Holland Park.

Willow Culture and the Utilisation of Willows.

Condition of Crops and State of Trade.

The weather conditions of 1926 were moderately favourable to the Willow Crop. From personal observations and reports

which the Willow Officer has received, the yields will be medium, and the greater portions of the crops will consist of rods of medium size. Spring frosts caused damage to young shoots in several parts of the country, the result being the production of branched rods (rough). On this account the costs of preparation of rods for use (sorting, peeling, etc.) will be greater than in the case of the 1925 crop.

Willow beds have been planted in new areas in Wiltshire and Cardigan. From enquiries which have been made it is probable that the number of new willow growing centres will be increased in 1926-27.

The demand for willow rods by the basket-making industry has temporarily diminished owing to industrial depression.

The price of willows remains stationary.

Enquiries.

The total number of enquiries answered during the year was 118, distributed as follows :—

Gloucester (including Bristol)	9
Hereford	1
Somerset	24
Wiltshire	10
Worcester	2
Other areas	72
	118

Advice was given, as in previous years, on the suitability of land for certain varieties of willows, planting, marketing, cricket-bat willow culture and the treatment of insect and fungus attacks. Land was inspected with a view to willow planting in Somerset (2), Wiltshire (1), Hampshire (2), Yorkshire (1), Suffolk (1), Devon (1), Dorset (1). The figures in brackets refer to the number of cases dealt with in each county.

Special cases where advice was given were :—

The growing of willows on the Metropolitan Railway Company's Embankments in Middlesex.

The obtaining of suitable rods for tying purposes in the Celery growing industry and the cultivation of these varieties in Nottinghamshire and Lincolnshire.

The cultivation of willows in association with poultry husbandry in Wiltshire.

The obtaining of willow rods suitable for the fishing industry in Northumberland and Durham.

Sources of supply of suitable willow rods for basket-making firms employing exclusively disabled soldiers in Essex and Cambridge.

The cultivation of willows on small holdings in Somerset and Dorset.

The cultivation of willows for supply of material to a Rural Industry Community in Cornwall.

The growing of Cricket-bat willows on the plantation system in Hampshire and Dorset.

The cultivation of small-growing varieties of willows as garden crops by members of Womens' Institutes.

Cuttings of particular varieties were supplied from the Station's Variety Trial Beds for trial purposes to ten prospective willow growers in different parts of the country.

Exhibit.

Commercial varieties of willows as growing plants, willow products, prepared willow rods and specimens illustrative of problems in the industry were exhibited at the Royal Agricultural Show, Reading.

Agricultural Economics.

During the year ending 30th September, 1926, the following research and advisory work in Agricultural Economics has been carried out in the Bristol Province.

1. *Farm Management Studies.*

(*a*) *Costing.* Cost accounts were completed for eight farms in Somerset for the year ending Lady-day, 1925, and detailed reports were sent to the farmers concerned. In addition, three farmers in Somerset, two in Gloucestershire and one in Wiltshire were assisted in initiating and keeping cost accounts. 43 visits were paid to farms in connection with the cost accounts.

(*b*) *Simple Accounts—Somerset.* In connection with the investigation of simple accounts the names of about 290 farmers in Somerset were suggested. 160 visits were paid and of the accounts collected, 60 were found to be suitable for inclusion in the investigation. The analysis and tabulation of the accounts is proceeding and promises useful results.

(*c*) *Simple Accounts—Wiltshire.* The Wiltshire Agricultural Accounting Society was constituted on March 11th, 1926. The object of the Society is the collection of simple farm accounts for investigation from the farm management point of view. Prior to the inaugural meeting, steps had been taken to ventilate the proposal and to enrol provisional members. For this purpose a large number of visits were paid to farmers, accountants, markets and meetings, and propaganda was also conducted by letter and circular. After the formation of the Society very little time could be devoted to the furtherance of its objects owing to the demands made by other schemes upon the resources available. On May 14th, an intimation was received from the Ministry of Agriculture that the Economics grant had been increased with a view to the appointment of an additional student assistant to carry out work falling to be done in connection with the Accounting Society. Mr. M. C. Thorne was detailed for this work and it was decided that he should reside in Wiltshire with a view to economy in time and travelling expenses, and in order that he might be in close touch with members and with local conditions and problems. This step proved very popular with the supporters of the Society. At the close of the period under review the membership of the Society numbered 51 and completed accounts had been received from several of these. During the year, 26 visits were paid to farms in connection with the Accounting Society in addition to attendances at markets and meetings.

2. *Enquiries.* During the year 19 enquiries were dealt with. In five cases a system of cost accounts was initiated and the farmers were assisted in carrying it out, and in one case a system of simple accounts was suggested and put into operation. The remainder of the enquiries dealt with points connected with costing, book-keeping, income tax and other matters. Arising out of these enquiries seven visits were paid in addition to those included under the heading of costing, and some farmers were interviewed in the office.

3. *Correspondence Course in Farm Book-keeping.* A course of five papers written by the Advisory Economist was taken by sixteen students in the counties of Wiltshire and Gloucestershire. Each student was required to send in exercises on the subject of each paper for correction and comment. At the end of the course prizes were awarded for the best work sent in. The course was very successful and most of the students testified to the interest and value of the papers and exercises.

4. *Course in Agricultural Economics.* At the suggestion of the Head of the Department of Economics in the University, Agri-

cultural Economics was included as an optional subject in the curriculum of students reading for an Honours Degree in General Economics. The course was drawn up by the Advisory Economist and appears in the prospectus of the Faculty of Arts.

5. *Country Lectures.* In conjunction with the Director of Extra-mural Studies steps were taken to investigate the possibility of organising University Extension Lectures in country districts. A course of twelve lectures on " Agricultural Conditions and the Country Side " was drawn up by the Advisory Economist and this, together with other suitable courses, was brought to the notice of farmers and of agricultural and rural organisations with a view to the possibility of developments during the coming winter.

6. *Agricultural Shows.* Local agricultural shows were attended, maps and posters were exhibited and literature distributed.

7. *Summary of visits paid.*

Costing	43
Simple Accounts (Somerset)	160
Wiltshire Agricultural Accounting Society ..	26
General Enquiries	7
	236

PUBLICATIONS, 1926.

A. H. Lees.—

"The Influence of Summer Rainfall and Previous Crop on Fruiting of Apples."—Journal of Pomology and Horticultural Science, Vol. V., No. 3., July, 1926.

C. E. T. Mann and E. Ball.—

"Studies in the Root and Shoot Growth of the Strawberry, I."—Journal of Pomology and Horticultural Science, Vol. V., No. 3, July, 1926.

R. M. Nattrass.—

"The Control of American Gooseberry Mildew."—Journal of the Ministry of Agriculture, Vol. XXXIII., No. 3, June, 1926.

L. N. Staniland.—

"Experiments on the Control of the Apple Capsid Bug."—Journal of Pomology and Horticultural Science, Vol. V, No. 4, October, 1926.

T. Swarbrick.—

"The Healing of Wounds in Woody Stems."—Journal of Pomology and Horticultural Science, Vol. V., No. 2, March, 1926.

T. Wallace and C. E. T. Mann.—

"Investigations on Chlorosis of Fruit Trees."—Journal of Pomology and Horticultural Science, Vol. V., No. 2, March, 1926.

T. Wallace.—

"An Experiment on the Winter-Killing of Vegetable Crops in Market Gardens."—Journal of Pomology and Horticultural Science, Vol. V., No. 3, July, 1926.